HYDATID DISEASE.

HYDATID DISEASE,

WITH

SPECIAL REFERENCE TO

ITS

PREVALENCE IN AUSTRALIA,

BY

JOHN DAVIES THOMAS, M.D. (Lond.), F.R.C.S. (Eng.),
PHYSICIAN TO THE ADELAIDE HOSPITAL; MEMBER OF THE COUNCIL OF THE UNIVERSITY OF ADELAIDE.

ADELAIDE:
E. SPILLER, GOVERNMENT PRINTER, NORTH TERRACE.

1884.

369.

I should like to see a small army of helminthologists rise up and lay siege to the fortresses at present securely held by thousands of death-dealing parasites.—Cobbold.

Prevention is better than cure.

PREFACE.

Es ist eine alte löbliche Sitte, dass der Vater eines neuen Buchs—wofern er nähmlich über einen wissenschaftlichen Gegenstand schreibt—in mehr oder weniger Zeilen; welche man Vorrede nennt, sein Unternehmen rechtfertiget und die Gründe auseinandersetzt, welche ihn zu diesem Buchmachen bewogen haben.—*Bremser.*

What Bremser wrote with good reason more than half a century ago, applies with even greater force to day; for there is [illegible]

ERRATA.

Page 30, line 14, for *unfortunately* read *unfortunate.*
Page 51, line 10, for *hominus* read *hominis.*

reading public may very properly ask the *raison d'etre* of each new work.

It seems to me that there are two legitimate grounds upon which a writer may venture to inflict a book upon the public, viz., that he has something fresh to record, or that he may be able to present to the world old facts in new and more convenient garments. Upon both these grounds I humbly plead justification; for the statistics of Hydatid disease in Australia and British India are the result of my own inquiries during the last four years, and a similar remark applies to the investigation into the prevalence of Tænia Echinococcus in the dogs of South Australia and Melbourne. In the appendix I have recorded two new cases of the successful breeding of the adult Tapeworm in the dog by the administration of the Echinococci of man.

PREFACE.

> Es ist eine alte löbliche Sitte, dass der Vater eines neuen Buchs—wofern er nähmlich über einen wissenschaftlichen Gegenstand schreibt—in mehr oder weniger Zeilen; welche man Vorrede nennt, sein Unternehmen rechtfertiget und die Gründe auseinandersetzt, welche ihn zu diesem Buchmachen bewogen haben.—*Bremser.*

What Bremser wrote with good reason more than half a century ago, applies with even greater force to day; for there is an ever-increasing number of books upon all subjects. To what portentous dimensions medical literature has now attained was well shown by Dr. Billings in his masterly address to the International Medical Congress, held in London in the year 1881. Dr. Billings stated "that our medical literature now forms a little "over 120,000 volumes, properly so-called, and about twice that "number of pamphlets, and that this accumulation is now in-"creasing at the rate of about 1,500 volumes and 2,500 "pamphlets yearly." Well, indeed, may it be said that "of "making many books there is no end," and the much-enduring reading public may very properly ask the *raison d'etre* of each new work.

It seems to me that there are two legitimate grounds upon which a writer may venture to inflict a book upon the public, viz., that he has something fresh to record, or that he may be able to present to the world old facts in new and more convenient garments. Upon both these grounds I humbly plead justification; for the statistics of Hydatid disease in Australia and British India are the result of my own inquiries during the last four years, and a similar remark applies to the investigation into the prevalence of Tænia Echinococcus in the dogs of South Australia and Melbourne. In the appendix I have recorded two new cases of the successful breeding of the adult Tapeworm in the dog by the administration of the Echinococci of man.

I venture to hope that the facts thus elicited may prove of practical value in diminishing the serious prevalence of Hydatid disease in some of the Australian colonies. To know the extent of an evil, and its chief causes, are the most important steps towards its prevention. How very grave the extent of the disease has been—for example in Victoria—is shown by the facts, that during the fourteen years, 1868 to 1881 inclusive, 500 persons were known to have died of it; and that over 1,000 cases were recorded in the returns forwarded to me from the various hospitals of the colony. In my opinion it would be quite reasonable to estimate, that during the last twenty years from 2,500 to 3,000 persons, at least, have suffered from Hydatid disease in this one colony.

Such facts not only justify, but urgently invite, inquiry; and if any apology were needed for the publication of a work upon this subject, it would be found in the fact that if the natural history of this parasite were generally known to the public, and if that knowledge were universally applied in the daily life of the people, in ten years time Hydatid disease would be to all practical purposes extinct. Perhaps there is no other serious disease so completely within the beneficent domain of preventive medicine; but the most important advances in public hygiene must depend upon the intelligent co-operation of the individual citizen, for it is no more possible to make people healthy than it is to make them good by Act of Parliament. In making these assertions, I by no means wish to underestimate the value of the official machinery charged with the guardianship of the public health; but I do maintain that the most extensive sanitary reforms must depend upon the education (in the widest sense) of the general public, and it is by disseminating far and wide the knowledge of the causes of disease and premature death that public health officers and the medical profession can hope to reduce the present frightful mortality from preventible diseases.

In a small way, and within narrow limits, this has been my aim in writing this work. I have endeavored in Part III. to depict as completely as I can the life-history of Echinococcus, and in order to render this more clear, I have, in Part II., given an elementary general history of the Tapeworm family. In Part IV., I have recorded, as completely as the data at my disposal permit, the statistical prevalence of the disease in various countries.

This part is by no means as complete as could be wished, but I hope that what is recorded may stimulate other abler workers to extend our knowledge. In Part V. I have attempted to discuss the various conditions that influence the spread of Hydatid disease in different localities, and in Part VI. practical measures are suggested for its prevention. In the Appendix, I have recorded two instances of the successful breeding of the adult Tapeworm in the dog from the Hydatid of man. These should, properly speaking, have appeared in conjunction with the similar experiments of Finsen and Krabbe, and Naunyn (pages 80-84), but, unfortunately, my experiments were made after the earlier part of the book was printed.

It may, I think, be justly said that, up to the present time, there has not been any separate work published in the English language upon the subject of Hydatid disease. The excellent treatises of Cobbold entitled "Entozoa" and "Parasites" contain much valuable information upon Echinococcus, but the former is out of print, and the latter deals but briefly with the natural history of this parasite. I therefore venture to think that a work dealing as fully as possible with this part of the subject may prove of some general interest and utility, especially as indicative of the mode of prevention of Hydatid disease.

In writing this work I have drawn upon all the sources of information at my disposal, and I have endeavored in all cases to acknowledge the indebtedness. However, I must especially recognise my obligations to the writings of Professor Rudolph Leuckart, of Leipsic, and to a lesser, but still great, extent to the works of Cobbold, Küchenmeister, von Siebold, Rasmussen, Naunyn, Huxley, and many others. To Professor Leuckart I return my most grateful thanks for his permission to avail myself of the text and many excellent illustrations of his masterly treatise, "Die Parasiten des Menschen," and I can only regret that the whole of this classical work has not been translated into English for the benefit of those of my countrymen who do not read German. Plates I. and. II. are excellent photo-lithographs by the Government Printer of engravings by the late Dr. Rasmussen, of Copenhagen, in his work "Bidrag til Kundskaben om Echino-"coccernes Udvikling hos Mennesket." Plates III., IV., and V. were drawn upon stone by Dr. Dunlop, now of the Adelaide

Hospital, and for several years one of the artists of H.M. *Challenger* Commission. They give faithful representations of specimens of Tænia Echinococcus collected and mounted by myself.

In the preparation of the statistical part, I must acknowlege my obligations to the late Sir William Morgan, K.C.M.G., by whose lamented death I have lost a kind friend and South Australia has lost an honored citizen. To the Hon. John C. Bray, Chief Secretary of South Australia, I have to express my grateful thanks, for not only has he used his personal and official influence in aiding me to procure reliable statistics from all the colonies of Australasia, but he has also sanctioned the publication of this work by the Government Printer, thus enabling it to appear in more complete form than would otherwise have been practicable under the circumstances. Most courteous and ready help has also been received from Mr. Graham Berry and Sir Bryan O'Loughlen in Victoria, from Sir Henry Parkes in New South Wales, as well as from the Governments of Queensland, New Zealand, Tasmania, Western Australia, and Bengal. I also desire to record my indebtedness to Mr. Spiller, the Government Printer, and his staff, for the invariable courtesy and constant aid received whilst the work was passing through the press.

In conclusion I would state that as this work has been directed towards the prevention of Hydatid disease, I have not discussed the more strictly professional aspects of the question, viz., the diagnosis and treatment of the malady.

J. D. T.

North-terrace, Adelaide,
January, 1884.

CONTENTS.

PART I.

INTRODUCTION.

PART I.—INTRODUCTORY.

Parasites are independent organised beings descended from peculiar animal or vegetable parents, which require, in order that they may be enabled to complete their development, growth, or reproduction, to take up their abode, either constantly or temporarily, in or upon a second animal or vegetable organism of a different kind, from which they also derive their nourishment:

Human Parasites are those which select the human body as this second organism (Küchenmeister).

Parasites are divided, according to their chosen abodes, and to the kingdom of nature of which they are members, into four groups:—

Vegetable external	parasites	—Epi-phytes.
" internal	"	—Ento-phytes.
Animal external	"	—Epi-zoa.
" internal	"	—Ento-zoa.

The term **Pseudo-parasites** is applied to those plants or animals which, either in a living or dead state, reach the intestinal canal of other animals, in consequence of impurities in food or drink, or get into the air passages or upon the surface of the body; but even when this takes place, during the life of the "host," can only continue their existence for a short time, and are soon subjected to the ordinary laws of chemical decomposition, and are never capable of continuing their species there.

As far as is yet known, the only animals which occur as parasites, in or upon the human body, belong to the classes of Insects, Worms, and Infusoria.

Parasites vary in their degrees of parasitism. Thus, some seek merely a lodging on or in their host, and may even render useful service in return for the accommodation. Others, in addition to residence, demand also their board, and divert a portion of their host's meals to their own advantage. These are called by van Beneden, "Free Messmates" (*Commensaux*).

Others are not satisfied with merely taking up places of residence, and that their host shall find their food, but demand that it shall also do the cooking—in other words—they live on the digested food, or the living juices of the host.

This last group comprises the Tapeworm family, with one member of which we are specially concerned.

There is yet another group still more exigent in its demands, for not satisfied with sucking some of the juices, or absorbing a portion of the chyme of its host, it devours its benefactor. Thus the ichneumon deposits its eggs in the body of a caterpillar whose organs are devoured piecemeal by the young insect, which completes its development under the skin of its eaten-up nurse.

There is no class of parasites properly speaking, for most classes of animals reckon among their lower forms animals that are parasitic.

The most important parasites belong to the class of **Vermes** (or **Worms**) of the older zoologists.

By Linnæus, the class of **Vermes** was regarded as comprehending the most varied and heterogeneous forms of Invertebrata. Little by little, modern science has curtailed this group of animals of many of its former members, until at last no practically useful meaning remains attached to the term.

Even at the present time, there is considerable diversity in the mode of classification adopted by various zoologists, in dealing with the group of parasites with which we are concerned in this work, viz., the Tapeworms. That adopted by Rudolph Leuckart will here be followed. This authority recognises among the Annuloida, a class of **Platodes (Plattwurmer)**, possessing the following general characters: Body flattened, having no general somatic cavity; appendages, when present, consisting of a prehensile apparatus in the form of suckers, or hooklets, or both. In some rare cases, branchial appendages are present. As a rule they are hermaphrodite and produce a progeny which sometimes resembles the parent, but is sometimes very different from it, and then instead of directly arriving at sexual ripeness, it undergoes a remarkable series of changes, to which Steenstrup gave the name of "*alternation of* "*generations.*" The "*alternation of generations*" is thus defined by Steenstrup, "that an animal bears young which are, and remain, "dissimilar to their parent, but bring forth a new generation, whose

"members, either themselves or in their descendants, return to the "original form of the parent animal." The complex process referred to here, differs from the simple, although curious, metamorphosis undergone by tadpoles and insects.

" The first point of difference between the '*alternation of generations*' " and '*metamorphosis*' is that the young of those animals whose mode of " development comes under the former head, are not only unlike their " parent at first, *but remain so*. The second distinction rests on the " important fact that this young generation, so dissimilar to the parent " animal, brings forth new creatures which, either themselves or in their " descendants, revert to the original form of the first parent; whereas, " on the other hand, in simple metamorphosis, the dissimilar young, pass " by gradual changes into the likeness of the parent animal, and, until " the metamorphosis is complete, are incapable of generation. Steenstrup " has given the name of '*nurse*' to those young, which, whilst departing " from the parent type, remain and propagate under their own form."*

Huxley proposed for these "*nurses*" the name "*agamozooids*" These nurses, or agamozooids, do not produce ova, but develop by a process of internal or external *budding (gemmation)*.

The class of **Platodes** comprises several orders, of which, however, but one—the **Cestoda**—concerns us in this work.

---

* Von Siebold, "Tape and Cystic Worms," Sydenham Society's translation by Prof. Huxley, page 13.

PART II.

NATURAL HISTORY OF TAPEWORMS

(CESTOIDEA).

PART II.—NATURAL HISTORY OF TAPEWORMS.

Cestoda, Cestoidea—Tapeworms (English). *Bandwürmer* (German). *Vers Cestoides ou Acotyles* (French).

This order is defined as follows by Rudolph Leuckart:—

Platodes devoid of mouth and intestine, which in their typical forms, undergo generative changes, though budding from an usually pear-shaped "*Nurse,*" to which the buds remain attached for a longer or shorter time, so as to form a band-like colony

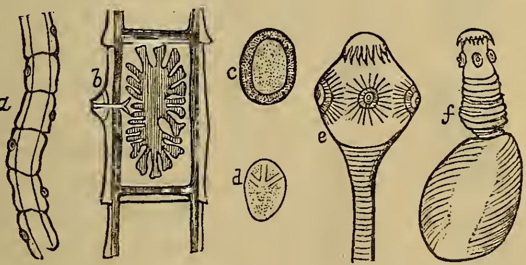
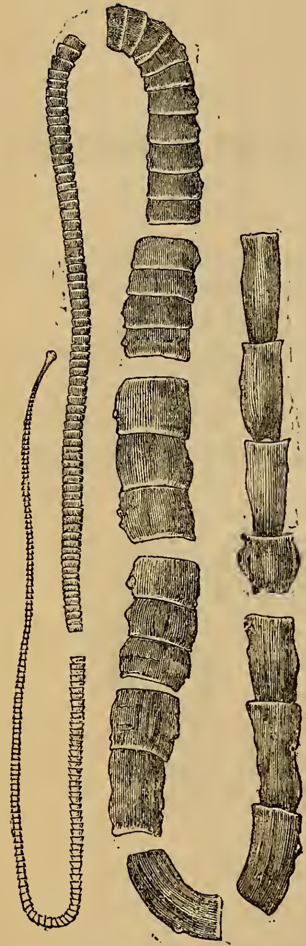


Fig. 1.—Stages of development of a Tapeworm (Cysticercus).
a. Part of the Tapeworm colony (Strobila).
b. Single joint (Proglottis).
c. Egg (early stage).
d. Egg containing Six-hooked embryo.
e. Tapeworm head (Scolex).
f. Bladder-worm or measle (Cystic stage).

(*Strobila*). The sexual animals (*Proglottides*) resulting from this process of gemmation, increase in size and degree of development, the farther they become removed from their place of origin, and this separation occurs by the continuous formation of new *proglottides* (or "joints") by the "*Nurse*" (or "*Head*"). The joints, as a rule, present no marked differences from one another, save in degree of development, or ripeness. The so-called "*Nurse*" known also as the "*Head*" (*Scolex; Amme*) is provided with two or four suckers, and very commonly also with an apparatus of curved claw-like hooks.

After Leuckart.
Fig. 3.—Separate joints (Proglottides) of Tænia Saginata in various degrees of contraction.



After Leuckart.
Fig. 2.—Tapeworm form of Tænia Saginata (T. Mediocanellata of many writers).

There is no distinction of dorsal or ventral surface in the head, which rather—in most cases—exhibits radiate, and not bilateral symmetry. With the aid of their suckers and hooks, the worms attach themselves to the intestinal lining of their "*hosts,*" which (with the exception of the very peculiar form Archigetes) belong exclusively to the Vertebrata. The "*Nurses*" *(Scolices)* develop themselves in a more or less complex way, as so-called *Bladder-worms,* from a six-hooked rounded embryo of minute size (the "*Hexacanth*" or "*Boring embryo.*") The bladder-worms inhabit the most varied structures (usually the interior of the serous cavities, or the substance of the parenchymatous organs) of the higher or lower animals, and obtain thence, by a process of passive migration, entry into the intestinal canal of their subsequent host.

Until recent times the "Tapeworm" was regarded by zoologists as a single individual animal, consisting like a centipede or lobster of a "head" and succeeding "joints." Modern biologists, however, regard the complete Tapeworm as a peculiar "*animal colony,*" consisting of more or less numerous individuals temporarily con-

nected together for the common advantage, but capable of leading separate, and quite independent existences.

Thus the isolated joints of various Cestoidea were described by Dujardin, as forms of a peculiar genus of worms, to which he gave the name of *Proglottis*. By others they were named *Vermes cucurbitini*.

Again, the head, in its isolated state, was in a like manner regarded as a peculiar animal, under the title of *Scolex*.

These terms are still in use, but divorced from the erroneous theories with which they originated.

The polyzooic nature of the Tapeworm band was however recognised by Linnæus, Blumenbach and other old observers, but with the mistaken idea that the chain or colony was formed by the adhesion of originally separate parts.

During the life history of every Tapeworm there is a stage where nothing is present but the head (scolex or nurse).

From the posterior end of this are developed successively, by a process of gemmation, the sexual proglottides, which are at first small and incomplete, but gradually assume their ripe condition; meanwhile they become farther and farther removed from their nurse, by the intermediate formation of new joints. At no period are sexual organs developed in the scolex.

The **Scolex**, in addition to its genetic relation to the segments, serves by its prehensile apparatus of hooks and suckers, to attach the entire colony to the wall of the intestine of the host.

It was formerly believed that still further services were rendered by the Head, for the suckers were regarded erroneously as mouths for the absorption of pabulum, and the curious "water vascular "system" (to be hereafter described), was regarded as a system of conduits for its distribution throughout the Tapeworm chain.

The proglottides remain connected together only for a limited but variable time. Sooner or later, those situated at the greatest distance from the Head, detach themselves. In the majority of Tapeworms this detachment does not occur until the ova contained in the joints have attained ripeness (*i.e.*, until a six-hooked embryo has formed in their interior).

But van Beneden has shown that in certain predaceous fishes, Tapeworms exist, whose proglottides attain ripeness only during their free life, and which in the course of their separate existence

grow nearly to the size of the entire Tapeworm from which they were detached.

As Leuckart remarks, no doubt can exist in such cases, about the independent animal nature of the proglottides.

Then there are other cestoids, such as Bothriocephalus, where the joints are detached, not singly, but in larger or smaller groups, and a third class exists, where, as in the non-segmented forms, no detachment of separate joints can occur.

We have thus all degrees of multiplication of parts, from the typical Tapeworm with its hundreds of joints, each possessing its complete sexual apparatus, down to a simple cestoid like Carophyllæus, where we find an animal with a single set of sexual organs, and a head provided with a prehensile apparatus.

The joints or proglottides, it is true, exhibit considerable differences in the same Tapeworm colony, but these variations are due merely to age and degree of development; it is not so, however, as regards the head. This exhibits great variety in different cestoda, but in all cases it is *asexual.* The Proglottides show (more or less decidedly) bilateral symmetry, whilst the Head very often presents marked radiate symmetry, as, for example, in Tænia Solium, where we find four suckers arranged in a quadrilateral figure, and the hooklets radiate regularly from a central spot at the vertex.

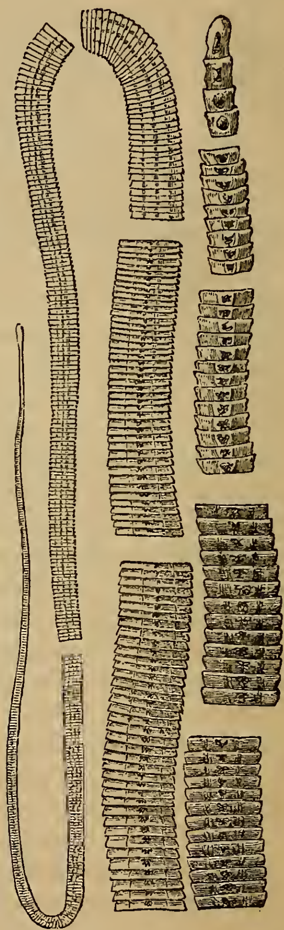


Fig. 4.—Bothriocephalus Latus. (After Leuckart.)

In other cases the radiate type is replaced in the head by a bilateral one, *e.g.* Bothriocephalus.

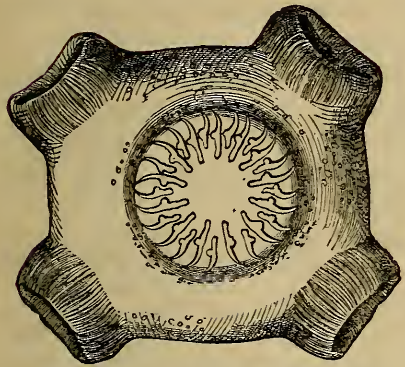


Fig. 5.—Summit of head in Tænia Solium, showing circlet of hooklets and the radiate arrangement of the four suckers. (After Leuckart.)

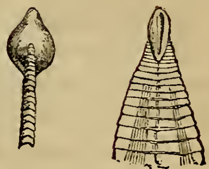


Fig. 6.—Head and anterior end of body of Bothriocephalus Cordatus, showing bilateral symmetry. (After Leuckart.)

GENERAL ANATOMY OF TAPEWORMS.

The **Cestoidea** possess no mouth, anus, or alimentary canal; they are likewise devoid of blood-vessels, and of any fluid of the nature of blood—nevertheless, they are by no means of simple structure.

They possess a well-marked muscular system, a complicated sexual apparatus, a curious system of vessels permeating the entire colony, and a nervous system represented in every proglottis, whilst the head frequently presents more or less numerous suckers, and one or more circlets of hooks—not rarely a retractile proboscis, as well as a portion of the water vascular system.

The entire "body" has distributed in it the so-called "calcareous corpuscles" in varying abundance.

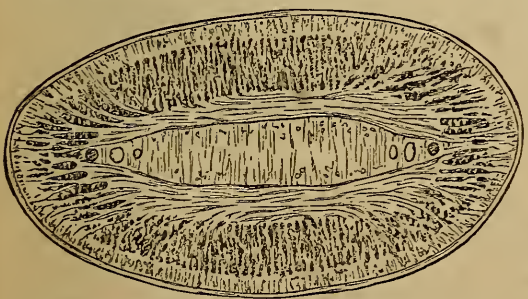


Fig. 7.—Transverse section of an old joint of Tænia Saginata, showing absence of any body-cavity.

All these structures deserve, at least a passing notice.

Upon transverse section of a proglottis it will be seen that these bodies are devoid of

any somatic or visceral cavity, hence their designation of parenchymatous worms *(vers parenchymateux)*.

In such a transverse section, a central and a cortical portion can be distinguished. The former contains the generative, nervous, and water vascular systems; the latter is richly provided with calcareous corpuscles, which are found also—but usually far less abundantly—in the median portion.

The **Calcareous Corpuscles** are rounded oval bodies, measuring 0·019 mm. (1/2,500 inch, Huxley) or less in diameter, which have a very wide distribution in the Tapeworms, both during their cystic and cestoid phases. They vary much in size, shape, and number in different Tapeworms, and in the different parts of the same worm. Thus, they may be kidney-shaped, or at times present the stratified appearance of starch granules, or show twin-like or triplet figures, &c.

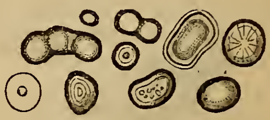


Fig. 8.—Various forms of Calcareous Corpuscles. (After Leuckart.)

They consist chiefly of carbonate of lime combined with an organic matrix of the same size and appearance as the complete corpuscle. The lime salt can be removed by treatment with acids, and as this usually—but not always—is accompanied by effervescence, it may be concluded that the acid combined with the lime is carbonic acid.

Various views have been held as to the nature and function of these curious bodies—Thus, they were formerly believed to be ova.

Von Siebold regarded them in the light of skeleton structures, Claparede thought they were excretory products, Leuckart is of opinion that these structures may serve, not only as protective and supporting skeleton structures, but probably also to neutralise the action of the acid intestinal juices, which the Tapeworms encounter during their sojourn in the intestines of their hosts. If this were so, it would be difficult to explain why the cystic forms which usually are richest in these corpuscles, should be the very forms actually digested by the juices of the host.

Virchow and Schiefferdecker regard them as derived from connective tissue corpuscles, by a process of partial or complete calcification. Huxley's investigations led him to a somewhat different conclusion.

He states* :—" Having paid great attention to the proccss, however, I " can decidedly affirm :—

" First, that acetic acid dissolves out the contents of the corpuscles in " young and fresh echinococci, without the least evolution of gas from " them; and that the same assertion holds good of the corresponding " corpuscles, contained in the spirit specimens of Tænia and Bothrio- " cephalus which I have examined.

" Second, that caustic ammonia produces little cavities and sometimes " a concentric lamination in these bodies.

" Third, that in a spirit specimen of an echinococcus from the panther " (which Dr. Hyde Salter kindly lent me) the corpuscles appeared " vesicular, without the action of any reagent.

" It may be said, then, that the peculiar strongly refracting corpuscles " of the cestoid and cystic entozoa usually contain an albuminous sub- " stance, and sometimes a fatty matter, but that this is very liable to " become replaced by a calcareous substance."

Sommer-Landois, however, state that the absence of effervescence is not an absolute proof of the absence of carbonate of lime, for that minute quantities of carbonic acid may, instead of escaping in bubbles, become absorbed in the nascent state by the fluid present.

All that seems certain then is, that these corpuscles vary much in number and structure, and that their function is *un*certain.

Fig. 9.—Shred of Echinococcus cyst showing the stratified structure of the cyst wall. (After Davaine.)

Cuticle.—Externally the body is enclosed in an elastic and apparently usually structureless cuticle, which varies in thickness in different cestoid forms.

This reaches its most marked development in the Echinococcus cyst, where it exhibits a characteristic stratified structure.

Very frequently the cuticle exhibits a vertical stratification, which, according to Sommer-Landois, is due to the presence of fine pore-canals, and these minute channels have been regarded as tubes for the absorption of nourishment.

For the most part, the external surface of the cuticle is smooth, but at certain situations it becomes raised into various forms of spines and hooks.

The *Hooklets* are the most considerable cuticular appendages, and when they are present, serve the important purpose of prehensile organs for the adult cestoid.

These hooks, however varied their ultimate forms may become, commence as simple conical elevations of the cuticle; these become

* Proceedings of the Zoological Society. Part xx., 1852, p. 113.

stronger, more curved, and develop a root process, and thus arise the most varied forms of these peculiar structures.

The characters and arrangement of the hooks present important differences in different Tapeworms, and so they become valuable marks of specific distinction. Still it must be remembered, that even in the same species, great variation of shape occurs, which is dependent, in part at least, upon the age and stage of development attained.

Fig 10.—Stages of development of Hooklets. (After Leuckart.)

When fully formed, these structures possess considerable firmness, and serve as grapnels to attach the Tapeworm head, and through it, the entire colony, to the intestinal mucous membrane of its host.

A stratified structure can in many cases be distinguished in the hooklets, showing that their development has been brought about by the deposit of successive layers of new material on the original simple spine. Simultaneously with the increase in the thickness of the stratified wall, there is a narrowing of the internal cavity, which may thus entirely disappear.

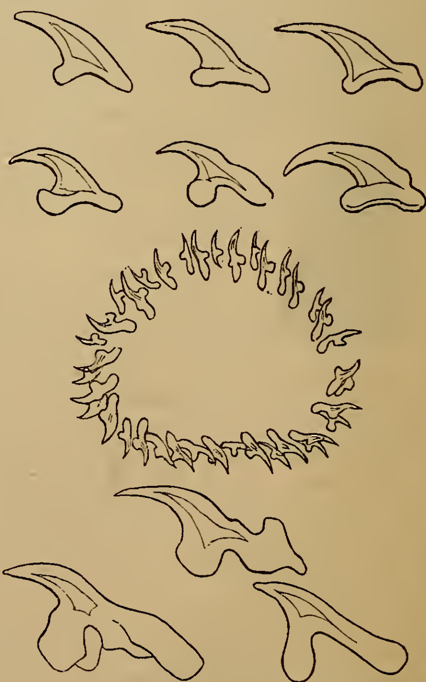


Fig. 11.—Various shapes of Hooklets in Tænia Echinococcus. (After Krabbe).

THE MUSCULAR SYSTEM.

The muscular system is well developed in the cestode, *i.e.*, the sexually adult forms, and it can be easily recognised in suitably prepared longitudinal and transverse sections, particularly in the younger proglottides, where the sexual structures are not yet so predominant as in the riper proglottides. The fibres run principally in accordance with the chief linear dimensions of the body,

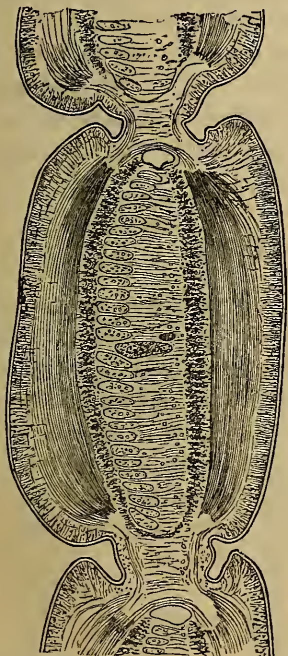


Fig. 12.—Longitudinal section through a young Proglottis of Tænia Saginata, magnified 25 times. (After Leuckart.)

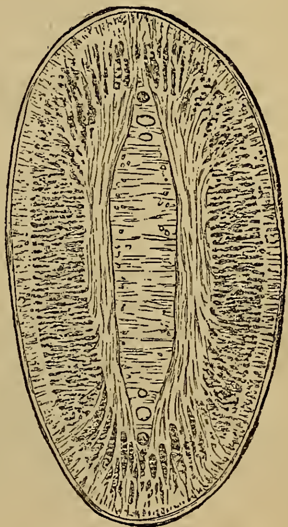


Fig. 13.—Transverse section of a somewhat old joint of Tænia Saginata, showing transverse and sagittal muscular fibres, magnified 38 times. (After Leuckart.)

longitudinal, transverse, and sagittal (or dorso-abdominal): The former groups are by far the most distinctly developed, and their action is evident. The longitudinal set shorten the segment antero-posteriorly—the transverse ones in a lateral direction.

By means of these muscular layers the proglottides become endowed with very active powers of movement. In the case of those Tapeworms whose segments detach themselves singly, the

actual separation is due, not alone to the peristaltic movements of the intestine of the host, but also to the independent contractions of the ripe proglottides themselves. The fibres which constitute the muscular layers mentioned, belong to the organic, non-striated kind; they do not possess a distinct nucleus, but consist of a homogeneous clear substance of highly refractive power, which at most exhibits a differentiation into cortical layer and axis substance. The extremities of the fibres are produced into slender, often dichotomously divided processes, and in some cases the fibres give off lateral branches, which may combine with similar processes from adjacent fibres, so as to form a contractile network.

In the Tapeworm head the muscular fibres undergo modifications of arrangement, in accordance with the number and arrangement of the suckers, rostellum, hooklets, &c.

THE NERVOUS SYSTEM.

As might have been inferred from their well-developed muscular system, the Cestoda possess a distinct nervous system. It consists of a central ganglion situated in the head, and of two lateral nerve trunks which extend through the entire chain of proglottides.

In lieu of two main lateral nerve trunks, there may be several smaller longitudinal threads running near each other on each side.

As has already been mentioned, Tapeworms have no alimentary canal, blood, or blood-vessels; they are, however, provided with a distinct and peculiar system of vessels, known as

THE WATER VASCULAR SYSTEM.

This consists of an arrangement of channels extending from the head, throughout the entire Tapeworm colony, to the distal end of the last proglottis; but this has no anterior opening comparable to a mouth, and no contents resembling chyme, but a watery fluid, holding in solution chemical bodies allied to xanthin and guanin. Hence the function of this system of tubes is commonly regarded as excretory.

The arrangement of these vessels is not the same in all Cestoda. In some cases two longitudinal vessels exist, but more frequently there are four present, especially in Tapeworms provided with four

suckers. At any rate, there are frequently four vesssels in the head, where they correspond in number and situation with the suckers. They are united by a simple, or more or less ramified, circular vessel, below the rostellum, when such a structure is present.

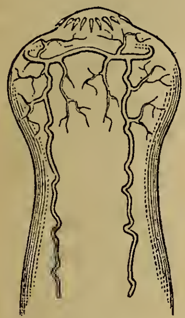


Fig. 14.—Head of Tænia Serrata, showing the arrangement of the water vascular system, magnified 24 times. (After Leuckart.)

The four vessels pass down from the head to the so-called neck, where they gradually diverge from one another, so as ultimately to assume a lateral situation.

In many species, these lateral trunks can be traced throughout the entire chain of joints. In some cases all four longitudinal vessels persist, and retain an equal size—in other cases, one canal on each side gradually diminishes in calibre, until at last it may entirely disappear in the more remote joints. At the posterior end of each joint there is a transverse communication between the lateral vessels.

Fig. 15.—Tænia Echinococcus, showing the longitudinal vessels of the water vascular system, united by transverse branches at the posterior end of each joint. (After Cobbold.)

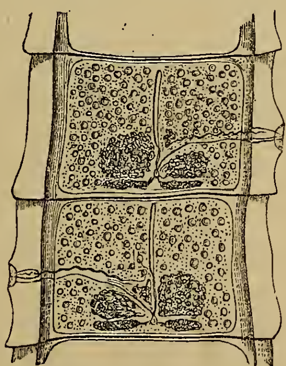


Fig. 16.—Two joints of Tænia Solium, showing longitudinal trunks and transverse connection of water vascular system.

When there are four longitudinal vessels, the transverse connection is in the form of a circular channel, just as is commonly seen in the head; when only two lateral vessels are present, they are united by a simple transverse vessel of the same calibre as themselves.

By von Siebold the water vascular system was believed to possess an inherent contractile power.

The current passing along this peculiar system of vessels runs exclusively from the

head towards the distal proglottis, and it is only in this direction that these canals can be injected.

These conditions are due to the existence of valves, which, situated above the transverse communicating vessels, project more or less into the interior of the tubes, and permit movement only in the direction mentioned.

At the posterior edge of the last attached proglottis, the water vascular system opens to the exterior. (See Fig. 15.)

The above description applies especially to the cestoids provided with four suckers on the head. In the Bothriocephali, which have only two grooves on the head, there is a different arrangement of these vessels. Here they exist in the form of several longitudinal trunks, frequently eight in number, joined by transverse and oblique anastomosing branches. Towards the head these join to form two cephalic trunks.

Fig. 17.—Diagram showing mode of union of the lateral and transverse vascular trunks in Tænia Solium. (After Cobbold.)

As to the mode of origin of the water vascular system, much diversity of opinion prevails amongst different writers. According to Pinter* this system takes its origin in a delicate network of very fine vessels, which at one end open into the large trunks already mentioned, and at the other, arise from minute funnel-shaped receptacles provided with cilia, and he adds that there exist no capillaries which do not take origin in such ciliated funnel-shaped receptacles, and that the channels themselves are closed tubes which are neither connected with lacunæ in the tissues of the body, nor do they open to the exterior.

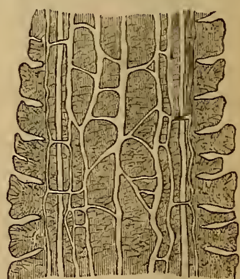


Fig. 18.—Water vascular system of Bothriocephalus Proboscideus, magnified 32 times. (After Steudener.)

This general arrangement, with minor differences, is, according to Pinter, universal in Tapeworms at all stages of their development and in all parts of their bodies.

* Untersuchungen über den Bau des Bandwurmkörpers; von Theodor Pinter. Wien, 1880.

THE SEXUAL ORGANS.

The anatomical structures already described, are common to all parts of the Tapeworm colony, although they present minor local differences ; not so the sexual organs, for they are never found in the head.

At first, the proglottides also are devoid of sexual parts and products, but this only continues to be the case for a limited period, for soon they develop these parts in a definite order, and ultimately the organs and their products attain so disproportionate a bulk, that the proglottides consist of little else. Especially prominent is the uterus, filled with its hard-shelled ova. It varies greatly in form in different Tapeworms, being branched, rosette-shaped, &c., and it thus serves as an important character for the differentiation of species among these animals.

The details of structure of the generative organs are, however, not to be ascertained without extreme difficulty, inasmuch as the limits of the several parts are much obscured.

However, it is easy to determine that each proglottis contains male and female organs, but although these co-exist, yet they do not attain their perfect development at the same time. This, according to Feuereisen, is well marked in Tænia Setigera of the goose, where in the young anterior proglottides, the male organs are so disproportionately developed that they appear to be exclusively masculine, whilst in the posterior distal joints, in which impregnation has occurred, and in which embryos have been developed, the male organs have undergone atrophy, and even have, in greater or less degree, disappeared.

Moreover, as the uterus becomes filled with ripe ova, those portions of the female organs which were preparatory undergo atrophy, as did the male organs at an earlier stage.

In general terms it may be stated, that although there are great variations in the structure and arrangement of the sexual organs in different species, yet, as a rule, the male organs consist of more or less numerous testicular vesicles, whose ducts lead into a seminal canal, provided at its terminal end with a cirrus-sac and cirrus, the last-named organ being really the penis or intromittent organ. The male generative organs exhibit far less varied differences in the different species than do the female ones.

The female generative organs consist of an ovary (Ovarium, Keimstock) and a vitelligenous gland (Dotterstock, Eiweissdrüse), both of which co-operate to form the egg; also of a vagina for the reception of the semen, and a uterus in which the fertilised ova are accumulated. Frequently also there are found a seminal vesicle connected with the vagina, and finally a shell-forming gland. Very striking differences exist among the Cestoda of the groups Tæniadæ and Bothriadæ, in the conditions of these organs. In the former there is no special outlet to the uterus by which the ova can be discharged externally. Hence the egg-formation in each proglottis lasts only for a limited period, and all the ova in a given joint are found in about an equal stage of development, after they have once entered the uterus.

In the Bothriadæ, on the other hand, the uterus is provided with an efferent canal, by which the ova escape in succession as they become ripe, and fresh supplies of ova are developed so long as the worm remains in the intestine of its host.

The ova of the Tæniadæ reach, whilst still enclosed in the proglottis, a more advanced degree of ripeness than is the case in the Bothriadæ.

The outlets both of the male organs and of the female vagina are found at the so-called genital pore.

The male organs are in situation adjacent to the dorsal, the female to the ventral surface, and it is on this latter surface that the special uterine opening, when present, is always found, and commonly at or near the median line.

The genital pore then is formed by two outlets, *i.e.*, that of the male organs and that of the female vagina. Sometimes the margins of the genital pore are raised so as to form a papillary elevation, at the apex of which is found the outlet. In some cases there exists a common cloaca at the pore, into which the sexual orifices open.

Occasionally there may be seen projecting from the male orifice a slender process; this is the cirrus or intromittent organ. At its free end it has a fringe of spines, which doubtless aids greatly in fixing the organ to the terminal end of the vagina; at its proximal end the cirrus is attached to the muscular cirrus-sac, whose chief function appears to be to protrude and retract the cirrus.

In one sense the cirrus and cirrus-sac are merely continuations

of the vas deferens. In the cirrus and cirrus-sac the vas deferens has a straight channel; behind the cirrus-sac it has usually a serpentine or convoluted course.

Finally it breaks up into a number of delicate tubes, which lead up to the testicular bodies.

The number of testicular vesicles varies greatly in different species, there being sometimes hundreds of them, at other times only a few dozens, or even only two or three. The variations found in the male generative organs are therefore by no means of a radical nature. In the case of the female organs, however, it is very different, and the variations fall mainly into two groups, one of which prevails in the Tæniadæ, the other characterises the Bothriadæ.

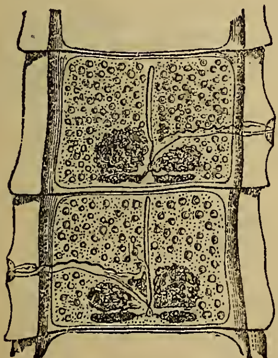


Fig. 19.—Sexual organs of Tænia Solium, showing alternating lateral position of genital pore.

Fig. 20.—Sexual organs of Bothriocephalus Latus, showing median position of outlet, uterus, vas deferens, &c. (After Leuckart.)

In the Tæniadæ there is absence of an uterine opening, and the vitelligenous gland is but little developed. The details of structure vary in different species, and particularly according to the length of the proglottides. The uterus is at first merely a narrow straight tube, but later on, when distended with ova, it may become a large bulged-out sac, or it may develop lateral projections, or even branched appendages of considerable length.

In some cases, as in *Tænia Elliptica,* the uterus may break up into a number of separate rounded bodies distended with ova.

The second type is found in the Bothriadæ. In them the male sexual organs present no very marked deviation from the type

found in the Tæniadæ, but the outlet is placed usually in the median line, and not at the edge of the proglottis. The vas deferens consequently runs in the median line, adjacent to what may be regarded as the dorsal surface of the joint.

The vagina and uterus occupy a somewhat corresponding situation towards the ventral surface. The former runs a nearly straight course, but the latter, at least in the older segments, forms a number of convoluted loops, on each side of the median line.

THE OVA AND THEIR CONTAINED EMBRYOS.

These, like the female genital organs, present great varieties in shape, size, and even structure in Tapeworms.

Fig. 21.—Egg of Bothriocephalus Latus, with yelk-cells and shell, magnified 400 diameters. (After Leuckart.)

In the Bothriocephali they are of considerable size, and are provided with a firm shell, usually ovoid in shape, which encloses the ovarian egg imbedded in yelk-cells.

Fig. 22.—Egg of Tænia Elliptica, magnified 600 diameters. (After Leuckart.)

Fig. 23.—Recently formed egg of Tænia Marginata. (After Leuckart.)

Fig. 24.

Frequently the shell is provided with an operculum or lid, as in Fig. 25, c.

The corresponding structures in the Tæniadæ, as they appear *in situ* at the terminal end of the uterus, are very small rounded spheres, with very faintly granular, almost clear "yelk," and a thin, by no means firm, envelope, which, in many of the larger species, is produced into one or two tails. The appearances just described are to be found only in the contents of the younger (unripe) proglottides. In the ripe segments we find the ova developed into larger, usually rounded spheroidal bodies, with a more or less thick and firm shell, in the interior of which is a clear vesicle, provided with six* curved hooklets; this is the so-called Hexacanth embryo, or Boring embryo.

* In some cases there are only four to be found, and occasionally the hooks are much more numerous. Thus Heller has seen embryos of Tænia Saginata with twelve, sixteen, and even thirty-two hooks, and Leuckart has met with instances in the same Tapeworm, and in Tænia Elliptica, with ten and twenty-four hooks.

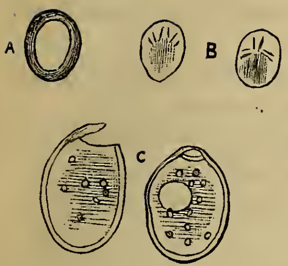


Fig. 25.
A—Early stage of Tapeworm Egg.
B—Later stage of Tapeworm Egg containing Six-hooked Boring Embryo.
C—Ova of Bothriocephalus with operculum.

It will thus be seen, that in the Tæniadæ the development of the embryo and the growth of the proglottis proceed *pari passu*. The size of the embryos and their hooks varies much in the different species. The embryonic hooklets are arranged in pairs, two directly anteriorly, and the remaining four in bilateral pairs. They are capable of very active and definite movements, which will be noticed later on. No muscular apparatus can be discovered, so that the hooklets owe their motor power to the sarcode out of which the body of the embryo is formed.

The shells which enclose, but do not closely invest the embryos, present numerous variations; thus there may be two or even three such envelopes; the external surface may be smooth or irregular, &c.

According to Leuckart, the fully formed ova really consist, not only of the original product of the ovary, but in addition they have an albuminous enveloping mass, the whole being enclosed in a delicate transparent covering, so that it has the appearance of a simple cell, with a vesicular nucleus.

As usual, the development of the embryo occurs by a process of cleavage of the ovum, which takes place as a rule with tolerable regularity until a mulberry mass (morula) is formed, but this according to van Beneden and Moniez does not, at any rate in all cases, simply and directly become converted into the future embryo. According to these observers, the mulberry mass becomes divided into a central and a peripheral portion, the latter in process of time becomes separated by a considerable space from the former, and ultimately it disappears entirely as a definite structure, leaving only a clear fluid.

The central part meanwhile has altered, its cells have become smaller, and so closely compressed together, as scarcely to be recognised as such.

This mass acquires an envelope (or more than one), and develops

into the embryo. Such are the phases observed in Tænia bacillaris and Tænia expansa.

In this process of embryo development many varieties occur, which, up to the present time, are not fully known.

It appears, however, that the first stages up to the cleavage into four segments are uniform in all. There are then present four round segments, each containing a large vesicular nucleus.

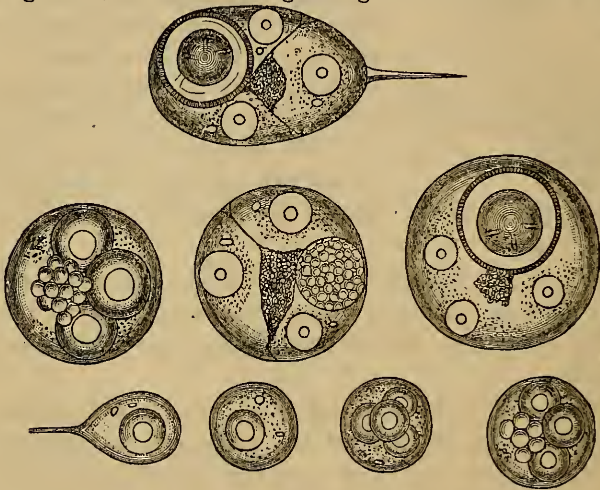


Fig. 26.—Stages of development of ova of Tænia Serrata and Tænia Marginata, showing process of yelk-cleavage, commencing at the third figure, counting from the left end of the lower series, and ending with the formation of the six-hooked embryo at the right-hand figure in the upper series. (After Leuckart.)

These are embedded in a granular matrix, and fill the greater part of the ovum cavity.

Later on, the segmentation does not proceed so regularly, for it now appears, that in one of the four yelk spheres, the cleavage continues, and thus we have three larger cells, with a mass consisting of a number of smaller ones. It is from the last mass that the development of the embryo proceeds, as is seen in Figure 26.

The number of the larger cells is not always limited to three, for sometimes four or five are observed. In course of time the embryo loses its cellular structure, and becomes clear, and nearly or quite homogeneous in structure.

The characters just described prevail among the *Tæniadæ*, and indeed also among the greater number of the *Bothriadæ*. In

Bothriocephalus latus, Leuckart observed distinct fibres attached to the base of the hooklets, which he believes to be capable of moving them ; also four rounded groups of cells imbedded in the substance of the embryo. The embryos of the *Bothriadæ* have many peculiarities ; thus, as a rule, they do not attain their complete development in the interior of the proglottides, as in the Tæniadæ, but in the free state, sometimes not for weeks or months after their escape from the maternal "joints." Again, they escape not only in the manner just mentioned, but they may also leave their eggshells and swim about in water by means of a ciliary mantle, with which they are provided.

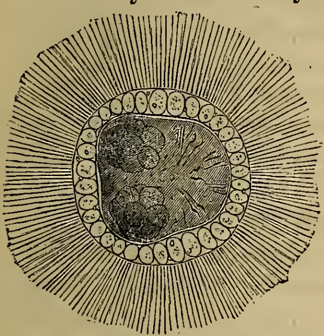


Fig. 27.—Ciliated embryo of Bothriocephalus Latus, magnified 500 times. (After Leuckart.)

The presence of this ciliary mantle is a peculiarity not only of various species of Bothriocephali, but also of other Cestoda, *e.g.*, Ligula, Schistocephalus, &c.

It is, moreover, found not only in those Bothriocephali whose embryos enjoy a free swimming existence, but also in those which, like the embryos of the Tæniadæ, remain enclosed in their shells, and undergo merely a passive migration into the bodies of their future hosts. It must be remembered, however, that the ciliary mantle, although common, is not universal in its occurrence among the Bothriocephali.

Fig. 28.—Development of the embryo of Bothriocephalus Salmonis. (After Kölliker and Leuckart.)

DEVELOPMENT HISTORY OF TAPEWORMS.

Before the six-hooked embryo reaches its final stage of development as a Tapeworm head, a series of most remarkable and intricate

transmutations occurs, which, until recent times, was quite unrecognised, and which has been discovered only by the efforts of modern helminthologists.

Still, various conjectures in the right direction had been formerly made; for example, Dujardin supposed that the embryo reached the alimentary canal of the host, and there by a process of direct metamorphosis became converted into a Tapeworm head, from which joints were developed, so as to form a Tapeworm colony.

Fig. 29.—Tænia Embryo; Hexacanth, Six-hooked or Boring Embryo. Proscolex of van Beneden.

The earliest observations of any real value for the solution of this problem were made by Stein and Küchenmeister. Stein found in the general body-cavity of the mealworm and its larva numerous cysts, which really were measles, *i.e.*, cysts containing Tapeworm heads, and which plainly showed by the presence of six embryonal hooks that they owed their origin to the metamorphosis of a hexacanth embryo.

In some measles only a simple rounded body, without a Tapeworm head, was present. This represented an early stage of development.

In others there was plainly a Tapeworm head. These cysts, no doubt, owed their origin to the circumstance that the mealworm had swallowed a brood of six-hooked embryos, whose eggshells had undergone digestion, releasing the embryos, which had then bored through the intestinal wall of their host, and after having reached the general body-cavity, had rested there, and become developed into cysts, in the interior of which the Tapeworm heads were developed, with their suckers and hooklets.

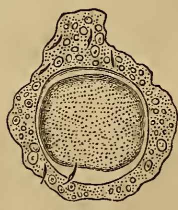


Fig. 30A.—Encapsuled Tapeworm embryo of the Mealworm. (After Stein.)

Fig. 30B.—Measle developed from the encapsuled embryo of the Tapeworm, Fig. 29. (After Stein.)

Even prior to the publication of these discoveries made by Stein,

a still more decisive impetus was given to our knowledge of this subject by Küchenmeister.

Indeed it is impossible to overrate the value of the Feeding experiments made by this observer, in their bearing upon helminthology. Küchenmeister showed in this way that the measle of the rabbit *(Cysticercus pisiformis)* became developed, in the intestinal canal of the dog, into a certain kind of Tapeworm.

The experiments thus made were speedily followed by numerous others, conducted by Küchenmeister himself; by von Siebold; and by many other helminthologists in various parts of Europe.

In this way it soon became certain that "measles" stood in a genetic relation to Tapeworms; in fact, that cystic worms had corelative cestoid forms, of which the former were merely a phase of development.

Before these feeding experiments demonstrated the facts, most diverse views prevailed, equally with regard to cystic and cestoid worms.

Thus Tapeworms were supposed to arise by spontaneous generation from the villi of the intestine.

A similar explanation was offered to account for cystic worms.

Indeed it was not till the time of Redi (1684) and Hartmann (1685) that "hydatids" were discovered to be animals at all.

After the time of Zeder and Rudolphi, the various kinds of "bladder-worms" or **hydatids** were collected into a separate group of animals under the name of **Cystici.**

It became known, however, that marked resemblances existed between the little heads connected with these bladder-worms and the heads of certain fully-developed Tapeworms, but the presence of a bladder of fluid instead of a jointed body, and the fact that bladder-worms occupied chiefly the closed cavities and parenchymatous organs, while Tapeworms inhabited the intestinal canal, prevented the recognition of their common relationship.

A step farther in advance was taken by Dujardin and von Siebold, who upheld the theory that bladder-worms ought not to be regarded as independent separate animal forms, but as developmental varieties of Tapeworms. Both observers thought that bladder-worms were developed from Tapeworm embryos, which instead of finding their proper road into the intestinal canal of their host, had lost their way, and had reached the parenchymatous organs, but finding

there no congenial habitat, had developed abnormally into vesicular worms, that in fact, *they had degenerated and become dropsical.*

Von Siebold strongly advocated this view. He recognised, for example (as Pallas and Goeze had done long before him), the exact resemblance between the head of the measle of the mouse *(Cysticercus fasciolaris)* and that of the Tapeworm of the cat *(Tænia crassicollis)*, and he believed that frequently certain individuals of the brood of *Tænia crassicollis* went astray into the bodies of mice, and degenerated there into *Cysticercus fasciolaris,* but if their hosts were devoured by a cat, and the parasites thus reached their proper soil, they could then cast off their degenerated segment (the vesicle) and attain to the full stature of segmented Tapeworms, and finally reach sexual ripeness.

But unfortunately for this theory, among other things, was the circumstance ascertained long since by Goeze, viz., that in the measle, and especially in the measle of the mouse, it was not the little head, but the bladder (caudal vesicle) that was first formed, in fact, that the vesicle produced the head, and not the head the vesicle. The theory of dropsical degeneration was, however, ultimately abandoned by von Siebold.

Van Beneden threw further light upon this subject by his observations made upon certain marine Tapeworms (Tetrarhynchi). He demonstrated that the cystic phase of development was not confined to the Tæniæ alone, but had a wide and probably general distribution throughout the Cestoda. Further, he showed that the cysticercoid stage of development was found in those fishes which were the common prey of the rapacious fish in whose intestines the cestoid forms were found; but van Beneden, like von Siebold, regarded the vesicular stage as an accidental rather than a necessary phase of metamorphosis.

Thus it was evident that something yet remained to be done, to decide the exact genetic relations of the cystic and cestoid forms of worms, and science is indebted again to Küchenmeister for the key to the problem. In the experiment already described, he proved that the vesicular worm of the mouse became converted into the Tapeworm of the cat. In the next place he demonstrated not only a second instance of a similar kind, but also showed that from the Tapeworm eggs could be bred, under suitable circumstances, the corresponding bladder-worm.

The results are repeated by him as follows*:—

"In the meantime I resolved to resume these experiments with the "Tænia Cœnurus, in order to obtain the remarkable phenomena of the "vertigo in sheep. On the 15th of May, 1853, I at last obtained the "cystic cœnuri. On the 25th of July mature proglottides of this Tænia "were passed by the dog to which the cœnuri were administered, and "these, in order to make the experiment under the most unfavorable "circumstances, were administered to a perfectly healthy two-year-old "wether, a description of sheep which is usually free from cœnuri. On "the 10th of August the sheep was affected with vertigo; on the 13th "the disorder had advanced so far as to necessitate the killing of the "animal. Herr Kärmsen, of Drausendorf, near Zittau, a very intelligent "agriculturist, who had furnished the animal for experiment, unfor-"tunately only sent me the head for examination, the rest of the body "being kept to be eaten by the people on the farm, so that I was pre-"vented from observing the immigration of the brood of the Tænia into "the other parts of the body. In the brain I found yellow striæ from "exudation passages, at the ends of which small vesicles of the size of a "grain of millet were situated. I found fifteen young vesicles of Cœnurus, "partly on the surface of the brain, which was reddened by inflamma-"tion, partly in the substance of the brain, and even in the ventricles."

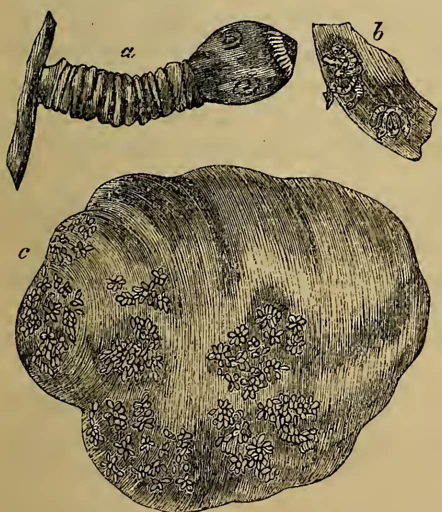


Fig. 31.—Cœnurus of the sheep. *c.* A vèsicle of natural size showing the groups of small Tapeworm heads (Scolices). *b.* Two groups of heads magnified four diameters. *a.* One of the heads greatly enlarged. (After Davaine.)

This experiment thus supplied two-sided evidence, for, in the first place, it showed—that in the intestine of the dog the bladder-worm, Cœnurus, became converted into the cestoid Tænia Cœnurus, and in the second place, it demonstrated that the six-hooked embryos of the latter, when swallowed alive by the sheep, developed into cystic Cœnuri in its brain.

These experiments were repeated by Küchenmeister himself, and by Gurlt in Berlin; by Eschricht, in Copenhagen; by van Beneden, in Louvain; by Leuckart, in

* Manual of Parasites. Küchenmeister. Sydenham Society's Translation. Vol. I., p. 31.

Giessen, and by several other observers, who were supplied with proglottides of Tænia Cœnurus conveyed in white of egg, and sent by Küchenmeister to them for experiment.

This method of experimental feeding has demonstrated the relations of a great number of cestoids. The employment of hosts suitable for the home of the various parasites is one of the necessary conditions of success, inasmuch as every parasitic animal has its one (or more) proper host, in which alone it will flourish, and not only so, but every cystic worm has its preference for certain organs of its host.

Even man himself has served as a *corpus vile* for helminthological experiment; thus some of the pupils of Professor Perroncito, of Turin, voluntarily swallowed the measle of beef, and, in one case, the student bred a fine specimen of Tænia mediocanellata. In a similar manner Dr. Oliver, in India, administered fresh living beef measles to a Mahommedan syce, and to a boy of low Hindoo caste, in each case successfully.

After the evidence supplied by these feeding experiments it is no longer permissible to regard the immigration of the six-hooked brood and its conversion into cystic worms as an accidental or abnormal phenomenon, but as a portion of a genuine life cycle. In short, *alternation of generations is the normal life career of these animals.*

But although these valuable experiments illustrated the phenomena of alternation of generations, still the details of the metamorphoses, which issued in these remarkable phases of animal life, yet remained to be worked out, and in this direction Professor Rudolph Leuckart, of Leipsic, has rendered signal service to science.

Detailed reference will be made hereafter to the developmental changes undergone by Tænia Echinococcus into its cystic form, but it will aid the comprehension of these metamorphoses if brief notice be taken of its allied forms.

The same conditions that have been contrived by the zoologist in the laboratory are adjusted by nature in the outer world.

When the Tapeworm inhabiting the intestinal canal of its host has attained to maturity, it does so first in its posterior joints, *i.e.*, in the proglottides most remote from the head, or scolex, and during the entire lifetime of the animal new joints are constantly

being formed behind the scolex, in consequence of which, the earlier-formed ones become farther and farther removed from their place of origin.

The number of joints or sexual individuals thus produced may be very few, as, for example, in Tænia Echinococcus, where there are but three; or they may be numbered by hundreds, as in Tænia Mediocanellata, in one example of which Perroncito reckoned 900 joints, and in this particular instance he estimated that every day there had been a production of 13·43 proglottides!!*

Whether the smaller Tæniadæ, such as Tænia Echinococcus, can compensate for the fewness of their proglottides, by the rapidity with which they can produce new ones, is not yet known.

Several circumstances must have an influence in determining the chances of any given Tapeworm in its struggle for existence; and as Tapeworms, like all other animals, cannot exceed some definite term of life, the continuance of the race must depend upon:—

1st.—The fecundity of the particular form; *ceteris paribus* the more numerous the proglottides and their contained ova, the better the chances of survival of some of the ova until their embryos can enter a suitable host.

2nd.—The vitality of the proglottides after they leave their host for the outer world: This probably varies in different species, and in the same species under different circumstances.

The proglottides themselves, at any rate in some species, possess very active powers of locomotion, so much so, indeed, that Pallas, who saw the isolated proglottides of Tænia Saginata, creeping upon the wall of a room at a height of several feet from the floor, named them *Ovaria ambulantia.*

Fig. 32.—Isolated proglottides of Tænia Saginata in various states of contraction.

In the case of the Tæniadæ, as has been already mentioned, the ova can escape only by rupture of the proglottis; in Bothriocephali, on the other hand, they can do so before the segments leave their fellow colonists.

* *See* Cobbold, Parasites, 1879, page 71.

Even in the Tæniadæ the eggs may escape by the tearing of the proglottides within the intestine of the host, so that the excrement appears as if sprinkled with white sand, or this may occur immediately outside the intestine, when Dujardin stated that the course of the proglottis could be recognised by a white milky streak of eggs.

In this way the ova may be widely dispersed over the soil, and become deposited in surface water, such as tanks*, dams, and swamps, and carried by rains and water streams, may obtain access to wells, &c.; or they may become attached to grasses, shrubs, salads, windfall fruits, &c., and even may be found high among branches of trees, as in the case of the Tapeworms of birds.

In this way a very wide distribution is obtained, and the chances of some embryos reaching a suitable host are greatly increased.

It must also be remembered that the vitality of the ova, and their contained embryos, is not dependent upon the life of the proglottis, for the putridity or mouldiness of the latter does not kill the former.

Then the ova themselves probably vary much in their tenacity of life, and authorities of equal weight are by no means agreed as to this matter.

Thus van Beneden writes:—†

"All the cestodes have eggs, usually in great number, and very well "protected against external agents. They endure heat and cold, drought "as well as humidity, resist by means of their envelopes the most violent "chemical agents, preserve the faculty of germinating, we will not say "for weeks, months, and years, but for centuries."

Other observers, however, do not credit the embryos with so great tenacity of life; thus Leuckart found in one of his experiments with the eggs of Tænia Cœnurus, that they had lost their power of development after eight weeks' immersion in water, and in one instance, twenty-four hours' exposure to the direct heat of an August day's sun in Germany had produced a similar result.

In all probability, then, there is much variation in the tenacity of life in the embryos of different Tapeworms, and the truth lies probably between the two extremes. At any rate it is certain that the embryos of Tænia Echinococcus can retain their vitality as

---

*Tænia ova have been found in tank water in India. See Cobbold. Parasites, page 78.

† "Animal parasites." The International Series. Vol. 20, page 209.

well in sultry India and sunny Australia, as in chilly Iceland or temperate Europe.*

An important element in the conditions influencing the prevalence of any given Tapeworm is the number of suitable hosts available. Some Tapeworms are very fastidious in this respect; thus all attempts hitherto made to breed Tænia Echinococcus in the cat have failed, and no observer has yet seen the hydatid cyst in the dog's viscera.

Ultimately, those embryos which are destined to a new lease of life enter, by some means, into the interior of the body of their future host. The usual, and perhaps the only, route by which they can do so is through the alimentary canal.

An entire proglottis and its contained eggs may, in some cases, become swallowed in the food or drink of the host. This is probably by no means a rare occurrence in so dirty an animal as the pig, which, especially in hot climates, such as India, eats all sorts of unutterable filth. Hence it is often to a very high degree infected with cystic parasites.

In man, such an occurrence as the swallowing of an entire proglottis of one of the larger Tapeworms is, of course, improbable, but it is not at all unlikely that in the case of a minute Tænia, such as Tænia Echinococcus (whose entire length does not average more than a quarter of an inch) a terminal proglottis, one-eighth of an inch long, may not rarely be swallowed unnoticed in drinking water, or on raw vegetables, such as water-cress, &c.

Far more often, separate ova find entry into the alimentary canal; usually the stomach is their next resting-place.

No doubt in some cases the embryos may be released in the mouth, their shells being crushed by the action of the teeth, but as this is unlikely to occur often, without the simultaneous destruction of the enclosed embryo, we may safely conclude that, in the vast majority of cases, the ova and their dangerous contents reach the stomach uninjured.

---

* Vital resistance of various Entozoa to heat.

Professor Perroncito made, between 1871 and 1877, a large number of carefully-conducted observations on this point; from these it appears—

1st. That Cysticercus Cellulosæ of the pig dies at from 45° C. to 50° C. (113° to 122° Fahr.)
2nd. The Cysticercus of Tænia Mediocanellata at from 44° C. to 46° C. (111·2° to 114·8° Fahr.)
3rd. Cysticercus Pisiformis of the rabbit at the same temperature.
4th. The Scolices of Cœnurus Cerebralis of the sheep died at 42° C. (107·6° Fahr.)
5th. The Scolices of the cysts of Echinococcus Polymorphus died generally between 47° C. and 48° C. (116·6° Fahr. and 118·4 Fahr), and Perroncito remarks "in no case amongst those I have "experimented on did it reach 50° C. alive." (Cobbold. Parasites. p. 69).

In this organ the proglottides, whether crushed or not, undergo digestion, and the eggshells become softened by the digestive juices. Under the combined action of the gastric juice and the muscular movements of the stomach, the eggshells become disintegrated, and the embryos are released.

Up to this time, in most Tapeworms, the embryo has submitted passively to the play of circumstances. In fact, it has been subjected to a process of passive migration.

The proglottis in which it was enclosed, of course, may have actively migrated, as has been already mentioned, and, moreover, those Cestoids whose embryos are ciliated have changed their locality actively. Nevertheless, in all cases the passage of the embryo into the stomach of its host has been strictly a passive immigration.

No sooner, however, is the embryo released in the stomach, than it commences a very active life. By means of its hooks it immediately begins to bore its way into the coats of the stomach, for whether armed or unarmed, the embryos are always capable of motion.

" The embryos which are destined to migrate into cold-blooded ani-
" mals are in general larger, possess larger hooks, and exhibit tolerably
" distinct movements, even at the ordinary temperature of a room.
" Those destined to migrate into warm-blooded animals are much smaller,
" have smaller hooklets, and only exhibit pretty distinct movements at
" an elevated temperature (at the temperature of the stomach)."*

As might be expected, the actual transit of the boring embryo through the lining of the stomach has not been observed, but the following description by van Beneden,‡ no doubt, exactly represents the process.

Fig. 33.—Tapeworm boring embryo.

" The following is the manner in which, some years
" since, we described these six-hooked embryos, produced by the Tænia
" of a frog, which were struggling by the side of each other on the slide
" of a microscope. The six hooks are arranged regularly in each indivi-
" dual, and move exactly in the same manner.

" They are very slight, and of nearly half the diameter of the embryo.
" Two occupy the median line, and unite like a single stylet; these are
" nearly straight, and a little longer than the others. They only move
" backwards and forwards. Their action is like that of parts of the
" mouth in certain parasitical crustaceans (the Arguli) when they endeavor

* Kuchenmeister, *loco cit.*, page 40. ‡ Animal Parasites, page 209.

" to pierce through the tissues. They are in continual motion to and fro. " The other four hooks are similar to each other, and differ from the " first in the point, which is curved into real hooks.

" They are arranged two and two, to the right and the left of the first, " so that they all meet at the base. Their movements are not the same " as those of the two first; they remain almost fixed at the base, while " they describe a quarter of a circle at the extremity. Let us imagine " the six hooks placed in front in the same direction. The two in the " centre advance, and the two pairs placed symmetrically by the side of " them are lowered and drawn backwards, and thus push the body " forwards. It is like the dialplate of a clock with three hands placed " by the side of each other; that in the middle would advance directly " forward, while the two others would be lowered until they formed a " right angle with the first.

" This is the movement which we observe in all the stylets: The " result of this is that we distinctly see the embryo penetrate between " the " debris," or into the crushed tissues which surround it. These " embryos imitate the movements of a man who wishes to get through a " window a little above him, and who, having succeeded in passing his " elbows through, pushes his body forward by leaning them on the " frame.

" We see the same efforts continue for hours; and we can easily " understand that there is no living tissue, however dense it might be, " except the bones, which could not be easily penetrated by these micro- " scopic embryos. This explains why we so commonly find cysticerci " in cysts along the intestines, and between the membranes of the " mesentery; and how they can, by piercing the walls of the vessels, " spread themselves into the most distant organs, by means of the blood, " which conveys them."

From this description it can easily be understood that these embryos may penetrate into the abdominal cavity, where some species may find a congenial home, and develop into cystic worms.

Others again pierce the walls of capillaries and venous radicles, and so enter into the blood current, by which they are swept on until, having passed along the portal vein, they enter into the portal capillary system of the liver. Others may enter the lacteal system of vessels, and pass into the systemic blood circulation through the thoracic duct. Probably however, many entering this system would be arrested in the lymphatic glands of the mesentery.

Probably—at least among the parasites infesting the higher animals—by far the most common course is for the embryo to enter the blood current, and to be carried by it along the portal vein into the liver, where a large proportion of the embryos of

some Tapeworms (such as Tænia Echinococcus and Tænia Serrata) remain permanently in the form of hydatids, and of Cysticercus Pisiformis in the rabbit. Others among the brood pass through the capillaries of the liver and by the vena cava inferior to the right side of the heart, thence by the pulmonary artery to the lungs, where, in the case of Tænia Echinococcus, many remain. Others, yet, pass through the pulmonary circulation to the general systemic circulation, by which they are carried to all the various organs and tissues fed by it. In this way the embryos of Tænia Cœnurus reach their homes in the brain of the sheep, those of Tænia Solium the eye and cellular tissue, those of Echinococcus the brain, spleen, kidneys, and even the bones themselves.


Fig. 34.—Brain of a lamb containing Cœnuri (natural size.) (After Leuckart.)

In the higher animals the liver is, of all organs, that most infested with cystic entozoa, and here they may take up their abode, or, on the other hand, only tarry for a time.

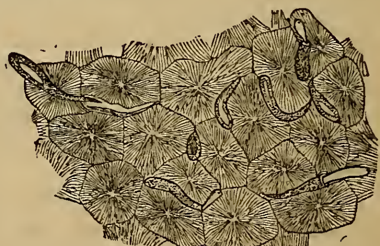


Fig. 35.—A piece of liver of rabbit, showing channels formed by Cysticercus Pisiformis, magnified ten times. (After Leuckart.)

Küchenmeister explained this preference for the liver by the assumption that the embryos obtained access to it by passing into the duodenum, and thence crawling up the bile duct.

This is of course a reasonable conjecture,* but it is unsupported by direct observation; on the other hand, Leuckart has actually discovered embryos in the blood of the portal vein, although he has uniformly failed to find them in the bile duct or its radicles.

Having arrived at the capillary portal system in the liver, the

* In the case of some Tapeworms there is strong reason to conclude that Küchenmeister's explanation holds good, viz.:—In the ducts of the liver in kangaroos there is very commonly met with a large Tapeworm (Tænia Festiva), which occupies the intra-hepatic bile ducts as its habitat. Its head may be found adherent at the peripheral ends of the small ducts.

embryo may be arrested in a minute vessel, and may there develop, finding in the vessel its earliest envelope.

But this is not always the case, for the embryo may recommence an active migration in the substance of the liver.

This is well seen in the case of the rabbit, whose liver is invaded by the embryos of Tænia Serrata (Cysticercus Pisiformis). (See Fig. 35.)

Here the active travels of the embryo are marked by minute channels and grooves, resembling those produced by the itch parasite in the skin. Precisely the same thing is seen in the brain of sheep attacked by Cœnuri (*i.e.* the embryo of Tænia Cœnurus), as in Fig. 34.

Having thus, sooner or later, reached its future lodging, the boring embryo ceases its migratory existence and becomes a *Resting scolex (Hydatid, Cysticercus, Cœnurus,* &c.).

We are indebted to Rudolph Leuckart for most of our knowledge of the changes next undergone by the embryo.

In the case of Tænia Echinococcus, a detailed description will hereafter be given of the metamorphoses next succeeding; but a brief description of the changes occurring in some of the other leading types of cystic entozoa will render its comprehension more clear.

The young bladder-worm causes in its immediate neighborhood a certain amount of irritation, in consequence of which a new formation of cells takes place in the connective tissue of the part, and this results in the formation of the "Adventitious fibrous "capsule" or sac, which envelops the parasite itself, and is a structure of great importance to the parasite, inasmuch as it is through it, by a process of diosmosis, that the necessary pabulum for its sustenance is secured.

Those entozoa which have reached congenial homes now proceed in their development; but, on the other hand, when favorable conditions are not present, the embryos die and undergo retrograde metamorphosis, which results in the formation of cheesy "tuber-"cular" or "atheromatous" masses, often mistaken for genuine "tubercle." "Many cases of miliary tubercular disease of parti-"cular organs may indeed consist in nothing else than the dead, "fatty, and calcified young of worms."*

* Küchenmeister. Op. cit., page 6

FURTHER DEVELOPMENT OF THE RESTING EMBRYO.

The embryo, having successfully pursued its active migration to its future resting-place, casts off its six hooklets, as is seen in the case of the mealworm parasite.

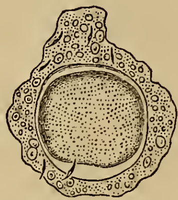


Fig. 36. — Early stage of encapsuled Tapeworm — embryo of mealworm, showing remains of the embryonic hooklets.

Fig. 37. — Later stage of the same parasite, with Scolex developed. (After Stein.)

The next change that occurs is a differentiation of structure, in consequence of which the central portion becomes clearer, and a cortical layer is formed.

Soon a muscular structure becomes developed in the latter; this consists of external circular and internal longitudinal fibres.

The entire structure now exhibits—

1st. An external adventitious sac, the product of the cellular tissue of the host's organ, and

2nd. The true parasite, which shows—

(*a.*) A well-marked external layer, the cuticular:

(*b.*) A cortical layer inside this, containing muscular fibres:

(*c.*) A clearer central mass.

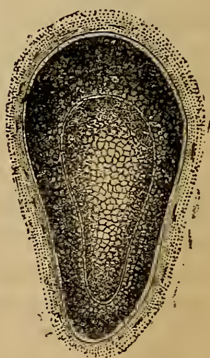


Fig. 38.—Early stage of development of Cysticercus Pisiformis, before the formation of the Scolex-bud, magnified sixty diameters. (After Leuckart.)

The last-named structure in the more typical bladder-worms is soon replaced by a clear fluid.

Quite early, too, the water vascular system becomes formed in the peripheral layer. It has the general character of a network of vessels spread over the entire area of the caudal vesicle.

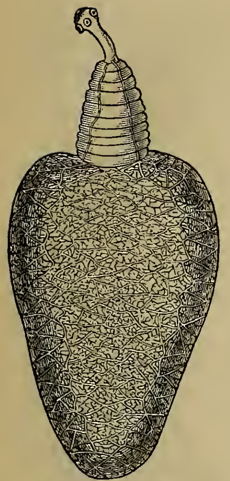


Fig. 59.—The head and "caudal vesicle" of Cysticercus Pisiformis, showing the ramifications of the water vascular system in the wall of the cyst. (After Leuckart.)

No communication can be discovered between this vascular system and the contents of the vesicle.

A ciliary apparatus, similar to that found in the corresponding system of the adult Tapeworm, is distinguishable, and, as it were to make the analogy complete, there exists, according to Wagener, at the posterior pole of the bladder-worm, a contractile sac, which opens externally.

The young worm retains, for a longer or shorter time, the above-mentioned characters as a watery vesicle.

The next important step is the formation of the Tapeworm head: The time when this occurs, and the minor details of its development, vary in different species, and indeed in the same species under different circumstances. In Echinococcus it does not take place for months. In Cœnurus it happens in the fifth week, while in the genuine Cysticerci it begins even earlier, usually in the course of the third week.

The earliest stage in the development of the head is the occurrence, at a certain spot in the sub-cuticular layer, of an active cell-formation, which forms a meniscus-like disc; this gradually rises so as to become a club-shaped bud, which projects into the interior of the cavity of the bladder-worm vesicle, or into the substance contained in the latter, as the case may be.

Fig. 40.—Juvenile measle of Tænia Serrata, showing at upper end the earliest stage of formation of the scolex-bud.

Fig. 41.—Further stage of development of the same. (After Leuckart.)

Simultaneously a pit-like depression occurs in the part of the outer surface of the vesicle, which corresponds with the base of the newly-formed bud, and this increases in depth in a degree proportionate to the increase in length of the bud-like process.

As this pouch is lined by a continuation of the cuticula of the bladder-worm vesicle, we may regard the bud as produced by an invagination or intus-susception of the wall of the mother vesicle, capped, however, by an additional collection of cells, derived from the sub-cuticular layer.

This bud-like process appears to carry before it a sort of envelope derived from the internal lining of the mother vesicle, in which, however, additional muscular fibres are developed. Leuckart has named this sac-like structure, which covers internally the little Tapeworm head, and separates it from the other contents (fluid or solid, as the case may be) of the vesicle—*The Receptaculum scolicis.*

The receptaculum differs much in its degree of development in different species of bladder-worms. It is well marked in Cysticercus Cellulosæ, where it encloses the Tapeworm head bud, and is very plainly seen at one stage of the latter, where it becomes bent upon itself, at an angle resembling a bent knee.

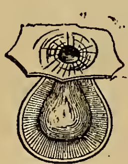


Fig. 42.

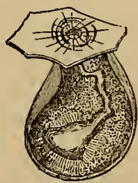


Fig. 43.

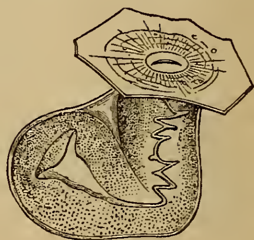


Fig 44.

Figs. 42, 43, and 44.—Scolex-bud of Cysticercus at different stages of development, showing the Receptaculum Scolicis. (After Leuckart.)

Soon, there can be discovered in the bud the indications of the water vascular system, consisting of four longitudinal vessels, which take their rise at the base point (or origin) of the head bud, from the vascular system of the vesicle. These are joined together at the distal end by a circular vessel: Later on, lateral branches with ramified twigs and ciliary apparatus are discoverable.

Fig. 45.—Scolex-bud of Cysticercus Pisiformis, showing water vascular system, magnified forty-five times. (After Leuckart.)

About the same time calcareous corpuscles appear, especially near

the base of the bud. Next are formed the rudiments of the suckers, rostellum, and crown of hooks, which arise, according to Leuckart, as follows:—

In order clearly to understand these metamorphoses, we must depict the head bud as a club-shaped structure, which is not solid, but, on the contrary, is occupied in its interior by a cavity which (in correspondence with the bulbous shape of the bud itself) is flask-shaped. The general plan is rudely represented by the finger of a glove, the tip end of which has been drawn into the remainder.

This peculiarity of structure is plainly seen during the formation of the suckers, rostellum, &c.

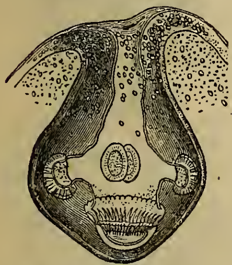


Fig. 46.—Recently developed head (scolex-bud) of Cysticercus Pisiformis. (After Leuckart.)

All these structures take their origin in the widened-out lower part of the bud cavity.

Lowest of all are formed the rostellum and crown of hooks, and a little higher up the suckers.

As can be seen in Fig. 46, there are sent out into the parenchyma of the bud, at four equi-distant radial points, projections of the common cavity, and it is at the terminal ends of these that the suckers are developed.

Fig. 47.—Transverse section through the anterior end of the rabbit measle, at the level of the suckers. (After Leuckart.)

At a later stage of development, the Tapeworm head may, in lieu of remaining within the vesicle, become partially or wholly extruded, as in Figs. 48 and 49. There will then be the appearance of a Tapeworm head with an imperfectly segmented neck, followed by the larger or smaller "caudal" vesicle.

Moniez holds somewhat different views as to the development of the Tapeworm head, but it appears probable that Leuckart's account, just given, is substantially the correct one.

The general plan of development, in the more common and typical forms of cystic worms, is as just described, but very con-

siderable variations occur, especially as regards the condition of the bladder-worm vesicle, its proportionate size, and the nature of its contents (whether solid or fluid), &c.

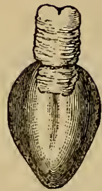


Fig. 48.—Cysticercus Pisiformis, with partially protruded head. (After Leuckart.)

Fig. 49. — Head and bladder-worm body of Cysticercus Pisiformis, with the head and segmented neck protruded. (After Leuckart.)

Thus, for example, in the Cysticercus Fasciolaris of the mouse (which in the intestine of the cat develops into the Tænia Crassicollis), the head and segmented neck attain a size so disproportionate to the caudal vesicle, that the last-named structure is not large enough to enclose it, and consequently this cystic form of worm was long regarded as a cestoid form.

Fig. 50.—Cysticercus Fasciolaris, showing the small size of the bladder, and the considerable development of the segmented neck, giving to this cystic worm the appearance of an adult Tapeworm. (After Leuckart.)

In the great majority of species the bladder-worm vesicle produces but one head, as, for example (Figs. 49 and 50), in all the genuine Cysticerci, but, even in these cases have occasionally been observed in which two, or even more, heads have been generated.

A second type is represented by Cœnurus, which is, as has already been mentioned, the cystic phase of the Tænia Cœnurus of the dog. The cystic Cœnurus is especially prone to infest the brain of the sheep, causing the disease known as the "staggers," "gid," or "vertigo."

In this type we find a higher degree of complexity, for the

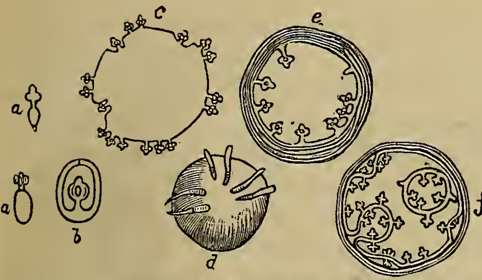


Fig. 51.—Diagrams showing plan of structure in the cystic types. Cysticercus, Cœnurus, and Echinococcus.
(a. a.) Cysticercus, with head protruded.
(b.) Cysticercus, with head enclosed in its cyst.
(c.) Cœnurus, with multiple Tapeworm heads (scolices) developed from its exterior.
(e.) Echinococcus Scolicipariens, showing heads developed in the interior. (Brood-capsules not shown.)
(f.) Echinococcus Altriciparieus, showing Brood-capsule and daughter cyst.
(d.) Six-hooked boring embryo alike in all.

Fig. 52.—Cœnurus of the sheep.
(c.) A vesicle of natural size, showing the groups of small Tapeworm heads (scolices).
(b.) Two groups of heads, magnified four diameters.
(a.) One of the heads greatly enlarged.
(After Davaine.)

mother vesicle, instead of producing only one Tapeworm head, generates hundreds of them.

So that the type Cœnurus stands in the same relation to the type Cysticercus as a compound animal does to a simple one.

In the third type, Echinococcus, a still higher degree of complexity is reached, for here there are produced, not hundreds, but thousands of Tapeworm heads.

Echinococcus thus resembles Cœnurus, in producing multiple heads, but it differs from it, however, not only in the vast number and small size of these heads, but also in the circumstance that while in Cœnurus (and in Cysticercus also) the Tapeworm heads are produced directly from the bladder-worm vesicle; in Echinococcus, the heads, instead of originating in this direct way, are formed in special vesicular structures, called "Brood-capsules," which themselves are formed in

large numbers on the inner wall of the bladder-worm vesicle (mother cyst).

As the structure and development of Echinococcus will be hereafter described in detail, it is needless to enter into the matter at any length in this place, but it will be instructive to mention those broad peculiarities which illustrate the differences between this type and those of Cysticercus and Cœnurus.


Fig. 53.—Scolex-bud of Cœnurus. (After Leuckart.)

Like the latter, it is many-headed (polycephalous), but, unlike it, the heads are vastly more numerous, much smaller in size, and they arise from brood-capsules.

In Cœnurus the heads lie mostly on the exterior of cyst; in Echinococcus, far more commonly, internal to it.

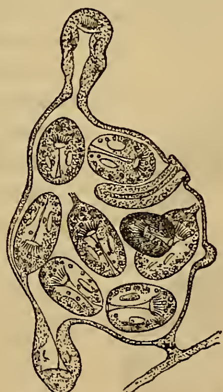


Fig. 54.—Brood-capsule of Echinococcus with Scolices in various stages of development. (After Leuckart.)


Fig. 55.—Diagrammatic representation of Echinococcus. (After Leuckart.)

The Brood-capsules measure about 1·5 to 2 Mm. in diameter (=0·059 inch to 0·078 inch), and this size is attained only by those older capsules which contain a dozen heads or more.

At the commencement, each brood-capsule contains only a single head, but the number gradually increases with the age of the capsules. The mode of development of the heads from the brood-capsules presents a great resemblance to that of the Cysticercus head already described.

There arises a protrusion on the external surface of the capsule which develops into a hollow bud—ultimately, the Tapeworm head.

This withdraws itself, through invagination of its basal portion, into the interior of the brood-capsule, so that the hook-apparatus and suckers become enclosed in a sheath, formed of the former neck.

Echinococcus not only develops brood-capsules in its interior, but also, frequently, secondary cysts; these in turn may form in their interior tertiary ones, and the latter may similarly breed quaternary ones, so that the entire arrangement may be compared to a "nest" of four pillboxes enclosed one in another.

As a rule, Echinococcus develops its brood-capsules and secondary cysts at a much later period than the heads are developed in the other cystic types (Cysticercus and Cœnurus).

Another striking peculiarity of Echinococcus is this, that the cystic form attains a magnitude far greater than Cysticercus or Cœnurus, and yet the cestoid form (Tænia Echinococcus) is of minute size, never exceeding about a quarter of an inch, and having only three, or at most four, joints, and it is of quite insignificant proportions, as compared with the cestoid forms of Cysticercus and Cœnurus.

Although the forms of cystic worms have been here grouped in three types, it must be remembered that many other forms exist (Cysticercoid, &c.), which developmentally represent vesicular (Cystic) phases, and yet in which either no caudal vesicle at all, or only a very insignificant one, is formed.

A. B. C.

Fig. 56.—Unarmed Bladder-worm from the abdominal cavity of Lacerta Crocea.

A.—With Head retracted.
B.—With Head partially protruded.
C.—With Head entirely protruded.
(After Leuckart.)

Again, the presence of a bag containing fluid is not universal, for cysticercoid forms are known where very little fluid, or even none at all, is present.

Even the peculiar mode of development of Echinococcus has been found to be partially simulated by a cysticercoid parasite of the earthworm.

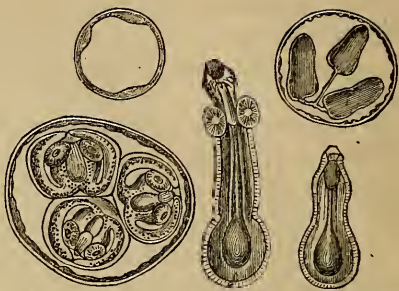


Fig. 57.—Development of an Echinococcus-like Cysticercoid from the body-cavity of the earthworm. (After Meczuikoff.)

PART III.

NATURAL HISTORY OF ECHINOCOCCUS.

PART III.—NATURAL HISTORY OF ECHINOCOCCUS.

Synonyms.—Hydatid; Hydatid cyst; Echinococcus cyst; Acephalocyst.—Hulsenwurm, Menschenvielkopf (German). Acephalocystis (Lænnec).

Tænia visceralis socialis granulosa	(Goeze).
" granulosa	(Gmelin).
Vesicaria granulosa	(Schrank).
Hydatigena granulosa	(Batsch).
Hydatis erratica..........................	(Blumenbach).
Polycephalus hominus	(Goeze).
" granulosus / " humanus / " echinococcus	(Zeder).
Echinococcus veterinorum	(Rudolphi).
" infusorium	(Leuckart).
" polymorphus	(Diesing).
" scolicipariens / " altriciparien s	(Küchenmeister).

The structure designated by these various names, and the disease occasioned by its presence in man, have probably been coeval with man himself; at any rate it is certain that the disease was well known to the earlier writers on medicine, for unmistakeable references to it are found in the writings of Hippocrates *(a)*, Galen *(b)*, and Aretæus *(c)*.

Hippocrates wrote thus—

"When the liver is filled with water, and bursts into the epiploon, in "this case the belly is filled with water, and the patient dies." *

† "Galen understands this case to refer to hydatids of the liver, but "finds difficulty in explaining how they can burst into the epiploon, "unless by ulceration. It would seem as if our author meant the cavity "of the peritoneum."

(a.) Born about B.C. 460; died about B.C. 357. *(b.)* Born about A.D. 130; said to have died at the age of 70, *i.e.*, A.D. 200. *(c.)* Probably lived in the reign of Vespasian, A.D. 9 to A.D. 79.

* The genuine works of Hippocrates. Aphorism 55. Section VII. Sydenham Society's translation. Vol. II., p. 770.

† Op. cit.

Aretæus refers still more distinctly to the disease, thus—

"This other form of dropsy is known; small and numerous bladders, "full of fluid, are contained in the place where ascites is found; but "they also float in a copious fluid, of which this is a proof, for if you "perforate the abdomen so as to evacuate the fluid, after a small dis- "charge of the fluid, a bladder within will block up the passage, but if "you push the instrument farther in, the discharge will be renewed. "This species then is not of a mild character, for there is no ready "passage by which the bladders might escape. It is said, however, that "in certain cases such bladders have come out by the bowels. I have "never seen such a case, and therefore write nothing of them, for I am "unable to tell whether the discharge be from the colon, or the "stomach." *

Paulus Ægineta mentions an operation for the removal of "Hydatids" from the eyelids, but it is very doubtful whether the disease mentioned was hydatid at all, for he describes the structures in question as follows—

"The hydatid is a fatty substance, naturally lodged under the skin of the eyelid, which in some persons, more especially in children of a more humid temperament, increases, until it becomes the cause of disagreeable symptoms by encumbering the eye, and thereby occasioning defluxions."†

Hydatids are also mentioned by Galen and Rhazes, as well as in the works of medical writers in the sixteenth and seventeenth centuries.

By the older authors, anything that produced a swelling resembling cystic worms was called a "hydatid."

The name Echinococcus was introduced into zoology by Rudolphi, in 1801.

Hydatids were formerly regarded—sometimes as enlarged and degenerated glands (Ruysch); sometimes as accumulations of pus and mucus mixed with serum (Piso, Malpighi, Boerhave, Haller); sometimes as the ends of blood-vessels, which had changed their nature (Spiegel, Diemerboock, Portal, Brandes, Grashius); sometimes—soon after the discovery of the lymphatic vessels by Aselli, in the seventeenth century—as enlarged lymphatic vessels, or varices of these vessels (Wharton, Bidloo, Nuck, Lettsom, Cruickshank, and down to Sömmering, and Hufeland); and sometimes as tumours produced by the accumulation of serum between the laminæ of the cellular tissue, which obliterated the vessel lying in their vicinity by pressure (Ruysch and Schacher); and, lastly, as degenerated mucus-sacs (Tode)—[Küchenmeister]. The animal

* The extant works of Aretæus, the Cappadocian. Sydenham Society's translation, p. 337.

† The Seven Books of Paulus Ægineta. Sydenham Society's translation. Vol. II., p. 270.

nature of the hydatids was apparently first discovered by Redi (1684) and Hartmann (1685), probably quite independently of one another. In 1691, Tyson, in England, also recognised their animal nature.

The subject was again studied by Pallas, in 1766, and subsequently. He first recognised the probability that hydatid cysts were always produced in connection with an animalcule or worm similar to the cysticercus, and he adds—

"That it is probable that the non-adherent hydatids sometimes "observed in the human body are either a species of the Tænia vesi-"cularis, properly so called, or of those singular hydatids which I have "remarked and described in the livers and lungs of calves and sheep, "and which ought certainly to be attributed to a living creature, and "which are evidently organised, at least as far as regards the interior "pellicle, which is studded with granulations."

Moreover, Pallas seems to have recognised the similarity, if not the identity, of the hydatid of a man with that of other animals.

The next decisive step in advance was taken by Goeze, in 1782, who, in addition to giving an accurate description of the animal, and recognising the Tapeworm heads with their suckers and hooklets, also showed that these represented an independent form, distinct from Cysticercus and Cœnurus.

He ranged the cystic among the cestoid worms, of which he formed a single genus, which he divided into visceral or vesicular Tænias and intestinal Tænias, and he placed in the first section the Tænia visceralis socialis granulosa, a worm which he found in the livers of sheep (*i.e.* Echinococcus).

Rudolphi recognised three species of his genus Echinococcus, viz., E. hominis, E. simiæ, and E. veterinorum, but he added that it was impossible for him to give distinctive characters, because the form of their body was too variable and their nature too little studied. He attributed to Echinococcus hominis and E. simiæ a single row of hooklets, and to E. veterinorum a double one.

Zeder, to some extent followed the views of Rudolphi, but used the name Polycephalus, and he distinguished the Polycephalus granulosus of the sheep from the Polycephalus echinococcus of man; he also placed the cystic and cestoid worms in separate families. In 1800 he gave a somewhat confused account of a case of hydatids of the brain in a woman, and he regarded the parasite as a species of Cysticercus.

Up to this time, it seems to have been the universal opinion that hydatid cysts always contained Echinococcus heads, but in 1804 Lænnec first threw doubt upon the correctness of this belief, and he founded a separate genus, "Acephalocystis." But whilst carefully and accurately describing the hydatid cyst as it is found in the sheep, with the granulations present on its walls, he yet commits the mistake of regarding the same parasite, when existing in man, as a distinct animal, which he termed "Acephalocyst."

A perhaps still more curious error was made by MM. Desmaret and H. Cloquet, who confounded the "cyst itself with the animal-"cule" (Busk).*

Fr. Leuckart regarded hydatids as infusoria allied to the genus Volvox; he recognised but one species of Echinococcus, which he called Echinococcus infusorium.

Livois † observed that Echinococci, both in man and the lower animals, were armed with *two* rows of hooks.

Dujardin reserved the name Echinococcus veterinorum for the only species admitted by him to exist.

Küchenmeister considered that two distinct species existed, viz., Echinococcus scoliciparìens and E. altriciparìens; the views of this authority will be again referred to later on.

It is only within the last thirty years or so, and by the labors of von Siebold, Küchenmeister, van Beneden, Leuckart, Rasmussen, Krabbe, Naunyn, and many other observers, that the real relations of this most important parasite have been ascertained, and the outcome has been the conviction that there is but one species of Echinococcus, and that it is the cystic phase of a minute cestoid Tapeworm, usually inhabiting the small intestine of the dog.

GENERAL DESCRIPTION OF THE HYDATID CYST.

If we have before us a living specimen of Echinococcus cyst in any organ, such as the liver, we shall at once distinguish a bladder-like vesicle, spheroidal in shape, which contains a watery fluid.

This bladder is imbedded more or less completely in the substance of the organ.

* Transactions of the Microscopical Society of London, 1844, p. 10.

† Recherches sur les echinocoques chez l'homme et chez les animaux. Par Eugene Livois, Paris, 1843.

Enveloping the hydatid when thus imbedded, there is found a capsule or sac, which is evidently a product of the organ or tissue invaded, and which has no organic connection with the hydatid itself. The external envelope just mentioned is the *Fibrous Capsule* or *Sac*—the *Adventitious Sac*.

Davaine regards this as really the only structure that can be appropriately designated by the term "cyst" (Kyste), and he strongly objects to the application of this term to the hydatid proper. He writes as follows:—

"Moreover, the expression Cyst, applied to the hydatid vesicle, is "entirely improper, as much from an anatomical as from a natural his-"tory point of view. A cyst being the product of the organ which "contains it, one should not give this name to a body completely strange "to the economy."*

However forcible and deserving of respect the objections of Davaine may be, there are, nevertheless, stronger reasons why the word "Cyst" should be applied to the parasite itself.

In the first place, the great majority of both English and continental authorities employ the expression in this sense, and again the older zoologists recognised the entire group of bladder-worms as "Cystici." The terms Cysticercus, Acephalocyst, &c., show how completely wedded to the parasite the term "cyst" has become.

Therefore, in this work, the parasite itself will always be referred to, when the word in question is used.

THE FIBROUS SAC—CAPSULE—ADVENTITIOUS SAC.

In the great majority of cases this is present, and, as has been already mentioned, it is derived from the connective tissue of the organ which harbors the hydatid. It appears to be merely the same structure as encloses any other foreign substance that lodges in the body, and it is composed of connective tissue.

It is, as will be hereafter seen, a structure of great importance to the life of the parasite. In the brain, and in the interior of serous cavities, often no such structure encloses the cyst; in the case of hydatids occupying the interior of the veins and arteries it also appears to be wanting.

For example, Dr. Allen† records the case of

"A large hydatid cyst, destitute of any adventitia, lying in the pelvic

*Traité des Entozoaires et des maladies vermineuses de l'homme, et des animaux domestiques. C. Davaine, Paris, 1877, p. 370.

† The *Australian Medical Journal*, April 15th, 1882, p. 160.

" cavity in the pouch between the bladder and the uterus; it is formed " simply of a clear transparent gelatinous sac, through which colonies of " scolices can be seen growing on the inner surface. The only adhesion " to the peritoneum was formed by a soft lymphy band of small size which " passed towards the fundus of the bladder. The cyst lay on the ante- " rior surface of the uterus, which was thoroughly retroverted."

A case of a somewhat similar nature, but occurring in the male sex, was communicated to the author by Dr. Poland, of the Sandhurst Hospital, Victoria. A boy, aged fourteen, was admitted suffering from peritonitis, of which he soon died. A post-mortem examination being made, there were found—

" Signs of recent peritonitis, and hydatids floating about in the peri- " toneal cavity; on further examination, a collapsed cyst was found " perfectly free. No evidence could be found of its attachment to any " structure."

The author has in his possession a considerable number of cysts, of about the size of large grapes, which were obtained from the abdominal cavity of a lemur. In this case, which first came under the notice of an exceedingly careful observer, no mother cyst was found, but the hydatids appeared to be floating free, in the fluid contained in the abdominal cavity.

In all other situations, except those mentioned above, it is constantly present, but it varies greatly in density and thickness. Thus it may range from a thin and almost imperceptible membrane up to a dense sac, reaching a thickness of $\frac{5}{8}$ of an inch or more, and the same sac often varies in thickness in different parts. Thus, at one spot, it may be only $\frac{1}{4}$ of an inch; in another, $\frac{3}{4}$ of an inch thick, or even more.

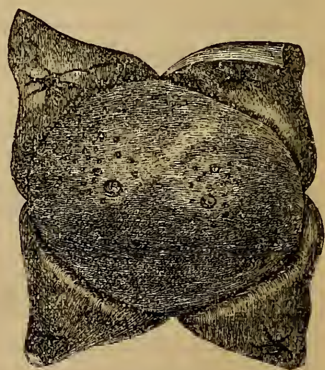


Fig. 58.—Hydatid cyst of ox showing capsule, divided by a crucial incision and reflected backwards—the hydatid shows on its surface numerous buds of exogenous cysts. (After Kuhn.)

The thickness of the capsule probably depends upon the amount of local irritation caused by the cyst, and hence it varies in different cysts and in various parts of the same growth, according to the varied amount of pressure, friction, &c. When of sufficient

thickness, it presents a stratified appearance on section, but the layers cannot be separated into distinct tunics. Probably, other things being equal, the thickness of the sac is proportionate to the age of its occupant. In very old cases, the capsule may become as dense as fibro-cartilage, or even as bone, and calcareous degeneration may occur in it, in patches of greater or smaller size. The calcareous matter consists chiefly of phosphate, mixed with some carbonate of lime.

The calcareous degeneration and extreme fibroid induration do not usually invade the capsule in an uniform manner, but patches here and there may be seen to have undergone these alterations, while the remainder of the sac continues unaltered.

There have been instances recorded where the parasite was found completely enclosed in a calcareous sarcophagus.

The internal surface of the capsule has a smooth, shining appearance in its normal state, and is, according to Vogel, lined by a more or less complete epithelium.

In young hydatids the interior of the capsule is whitish, but during life it is pink, from the blood contained in its vessels—at least, this was the case in one instance that came under the author's notice during an operation. In old cases, the internal surface may be irregular, and covered with more or less thick, creamy, or cheesy matter.

The capsule is nourished—and through it, also, the enclosed parasite—by blood-vessels derived from the neighboring tissues, and, in some cases, branches of vessels of large size may be seen to run, for a considerable distance, into the substance of the sac.

Upon the internal surface of the sac, the vessels often become dilated in a varicose or aneurismal manner, and they may rupture so as to cause ecchymoses along their course, or even produce a fatal hæmorrhage. Instances of this have been recorded both from the liver and lungs in man.

The shape of the sac, like that of the enclosed parasite, is usually globular, but it may be sacculated, and in the cases where the hydatid becomes multilocular, in consequence of obstacles which prevent its uniform development, the fibrous capsule exhibits corresponding loculi.

As the sac is a product of the organ invaded, it naturally shares its diseases; thus it may be invaded by carcinoma, or by lardaceous

disease. Instances of both these occurrences have come under the writer's notice.

When hydatids develop in the subserous cellular tissue, they may, in the course of their development, push themselves away from the surface of the organ in which they were at first imbedded, carrying with them the serous membrane, so that they appear as pedunculated growths, attached by a more or less elongated mesentery to their original site.

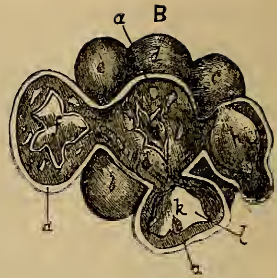


Fig. 59.—This figure represents, united into a group, several hydatids, each of which has a separate compartment of the general capsule. Some of these, *e.g.*, *a a*, have been opened by the incision, others *(c d e)* are still entire. (After Kuhn.)

This is well shown in the accompanying figure after Davaine.

In one of these cysts, the pedicle was not thicker than a horsehair. A somewhat similar specimen is preserved in the Museum of the University of Adelaide. Here a cyst, of about the size of a large plum, is attached by a slender pedicle, two inches long, to the mesentery.

The question naturally arises, whether this elongation and attenuation may not proceed a step farther, and result in the complete liberation of the cyst.

The following case is an interesting example of this condition.

Echinococci of Hepatic Origin in Douglas's Pouch :—

" Mrs. R., *æt.* 55, had a tumour
" on the right side of the abdomen,
" but knew nothing of its mode of
" growth. Abdominal organs

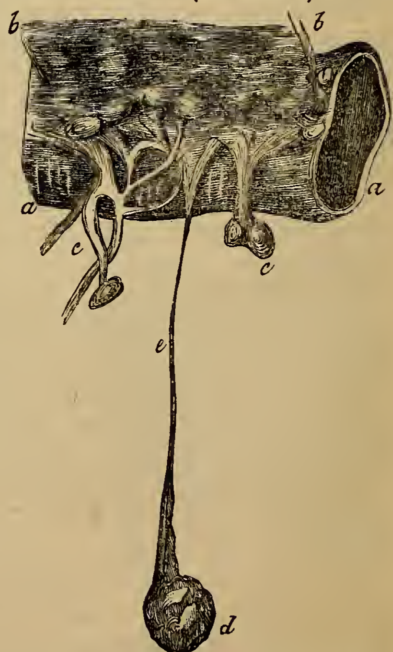


Fig. 60.—Pedunculated hydatid cysts observed by Charcot and Davaine. *(a. a.)* Small intestine. *(b. b.)* Mesentery. *(c. c.)* Cysts with short pedicles. *(d.)* Another cyst attached by a very long and slender pedicle *(e)*. (After Davaine.)

" seemed healthy, except the genitals. The senile uterus was pushed " forwards and to the left side, by a tumour as large as a child's head at " birth; it was rough, hard, and not fluctuating, and seemed to be " adherent to the posterior wall of the uterus, and not to be connected " with any other abdominal organ. Her sufferings arose from repeated " attacks of circumscribed peritonitis in the region of the tumour. She " died of some intercurrent affection, and a firm tumour was found at " the spot mentioned, which was adherent to the uterus, and at first " appeared to have no connection with the other organs; but a careful " search discovered a band, a foot long and as fine as a thread, running " to the right lobe of the liver. The tumour consisted of a dead echino- " coccus cyst, with an immense number of secondary vesicles.

" The connective band, and the deep yellow color, indicated the liver " as the original site of the cyst. It had developed in the liver, pro- " truded and become pedunculated, and, descending down into the pelvis, " had formed adhesions there."* .

THE HYDATID—HYDATID CYST—ECHINOCOCCUS CYST.

The fibrous capsule just described, although a structure of considerable importance to the parasite, is no more a portion of the latter than a glove is of the hand which it envelops. When the capsule is carefully opened, it will be found that the cystic parasite, in its normal condition, presents the appearance of a bag of membranous structure, distended with fluid, and entirely filling the capsule cavity.

This bladder is in a condition of elastic tension, for when a small puncture is made into it, a clear fluid is instantly ejected with considerable force.

The elastic property is vested in the wall of the bladder, which exerts a by no means inconsiderable pressure upon the fluid contents of the sac.

The amount of this pressure has not been ascertained in a sufficient number of cases to enable an exact statement of its amount to be made. However, in several instances under the observation of the author, where the intra-cystic pressure in cases of hepatic cyst was observed by means of a pressure-gauge, it amounted to about eleven or twelve inches of water.

Dr. Stone also measured the intra-cystic pressure in a case of

* "Medico-Chirurgical Review," July 1875, p. 229. There can be no doubt that this cyst really did take its origin in the liver, but the deep yellow color was by no means a proof of this, for all "atheromatous" hydatid cysts have a yellow color, which is not due to bile-pigment at all.

hydatid of the liver, under the care of Dr. John Harley, and found it equal to between eleven and twelve inches of water.*

In observing and estimating the intra-cystic pressure of hydatids, care must be taken lest the observer be misled by the indirect pressure exerted upon the cyst and its contents by neighboring muscular and other agencies. For example, when a cyst of the liver attains a considerable size, it becomes powerfully compressed between the diaphragm above, and the stomach, intestines, &c., below, and between the often tense abdominal muscles in front, and the comparatively unyielding ribs and vertebral column behind.

The result of the condition of tension in the cyst is, that every part of its external surface is closely applied to the interior of the capsule, whence the parasite obtains its nourishment by diosmosis. When the tension is lost by the removal of a part, or the whole, of the watery contents, the cyst collapses more or less completely, and thus is no longer capable of receiving its due supply of nutrient material from the capsule. The parasite then usually dies and undergoes degeneration.

This is probably the reason why many hydatid cysts are cured by a single evacuation of the fluid contents.

If a free incision be made into the interior of the cyst, it will be found that the edges of the incision curl in such a manner as to turn outwards the internal surface near the cut, and the cyst itself collapses, and falls away from the capsule, showing that there is no organic connection between these structures.† The greyish gelatinous-looking translucent cyst is not only distended with fluid, but usually contains within it one or both of two other kinds of structures, viz.—

Echinococcus-heads or Echinococci, which are really microscopic Tapeworm heads, and

Larger or smaller vesicles, *Daughter cysts,* or *Daughter vesicles.*

Frequently the latter contain within them smaller cysts of a second generation—granddaughter cysts—and these in turn may enclose still smaller ones, representing a third generation of cysts.

---

* St. Thomas's Hospital reports. New series. Vol. 8, 1877. Footnote to page 294.

† Küchenmeister, however, says that the hydatid may be in places adherent to its capsule.

It is this peculiarity of structure that has given origin to the term "pillbox" hydatid.

As has been already mentioned (see Part II., page 45), the Tapeworm heads do not arise directly from the wall of the mother vesicle, but within certain vesicular structures named *Brood-capsules.*

We have, therefore, to consider the following structures—

1st. **The Mother Cyst** itself.

2nd. **The Brood Capsules.**

3rd. **The Tænia heads,** or **Echinococci.**

4th. **The Daughter Vesicles,** and their contents.

5th. **The Hydatid Fluid.**

The mother cyst.—This consists of two distinct structures—an outer tough and thick layer, consisting of numerous superposed strata of a chitinous substance, to which the elasticity of the cyst is due, named by Huxley the "*Ectocyst,*" and an internal cellular layer, the "*Endocyst*" of the same author.

The *Ectocyst,* known also as the *Cuticula* by continental writers, presents, under the microscope, a peculiar stratified structure, which is quite characteristic. It shows no appearance of fibres or cells, and even under high magnifying powers it exhibits a nearly hyaline, or at most a faintly granular, appearance. Its thickness varies greatly, and increases with the advancing age of the parasite. The innermost layer of the ectocyst is whiter and softer than the outer ones, and is, in fact, of more recent formation.

The Cuticula of the hydatid, although resembling that of Cysticercus and of Cœnurus, yet differs from the corresponding structures in them in its much greater thickness, and in the absence of distinct muscular elements. According to Leuckart, however, traces of muscular fibres can, in suitable preparations, be distinguished in the larger-sized vesicles.

The stratified appearance is due to the successive formation of new layers by the endocyst.

The cuticula readily permits diosmosis to occur through its substance, and thus enables nutrient material to reach the actively

living endocyst. In this way too, bile, blood, and urinary derivatives may find entry into the intra-cystic fluid.

The *Endocyst* (Huxley). *Germinal membrane. Embryonic membrane. Keimmembran* (Müller). This is a very delicate membrane which, in some hydatids from the zebra, examined by Huxley, did not exceed $\frac{1}{2000}$ of an inch in thickness. According to this observer :—

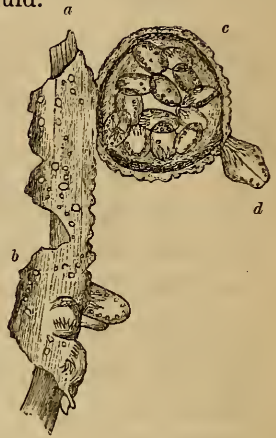


Fig. 61.—A piece of hydatid cyst, showing at *a.* a section of the stratified Ectocyst, covered with *b*, its Endocyst, from which springs *c*, a brood-capsule, containing in its inside several Echinococci, as well as one at *d* on its outer surface. (After Huxley.)

" It is composed of very delicate cells " $\frac{1}{2000}$ to $\frac{1}{5000}$ of an inch in diameter, " without obvious nuclei, but often containing " clear, strongly refracting corpuscles, gene- " rally a single one only in a cell. These " corpuscles appear to be solid, but by the " action of dilute acetic acid, the interior " generally clears up very rapidly, and a " hollow vesicle is left of the same size as the " original corpuscle. No gas is developed " during this process, and sometimes the cor- " puscles are not acted upon at all by the " acid, appearing then to be of a fatty " nature."*

Huxley further adds :—

" The inner surface of the endocyst is sometimes irregularly papil- " lated like a glandular epithelium, in consequence of the prominence of " separate cells, or its surface presents an even contour, from the pre- " sence of a structureless membrane which varies in thickness, and " seems to represent the inner portion of the blastema, elsewhere " slightly granular, in which the cells are imbedded. Solitary hooks are " scattered over the inner surface of the endocyst. I thought, at first, " that they had fallen from the echinococci ; but it is with some diffi- " culty that, even by the aid of pressure, the hooks can be so detached " from them ; and furthermore, the hooks in question had generally the " appearance of those forms found in the younger echinococci, from " which there is still greater difficulty in detaching them. I conclude, " then, that these hooks are developed where they are found, and that " they represent a sort of attempt to develop an echinococcus which has " gone no further."

According to Leuckart, the *Endocyst,* or as he terms it, the *Parenchymatous layer,* is composed of two parts, the inner one consisting of vesicular structures having the appearance of sharply-

* Huxley on the Anatomy and Development of Echinococcus veterinorum. Proceedings of the Zoological Society of London. Part xx. 1852, page 111.

defined clear drops. The outer layer has a more distinctly cellular character.

Between these cells are found coarsely-granular, highly refractive bodies, and calcareous corpuscles of varied size.

According to Naunyn, the inner surface of the endocyst is provided with cilia, sometimes occurring singly at intervals, sometimes in groups of from five to ten in number. Each is probably connected with a separate cell.

The Brood-Capsules.—Formerly, the echinococci were supposed to arise directly from the germinal membrane, by a process of gemmation, but the investigations of Naunyn, Rasmussen, Wagener, and Leuckart have demonstrated that this is not the case, but that they are produced within delicate sacs, to which the name of *Brood-capsules* has been applied.

Leuckart describes the brood-capsules as attenuated repetitions of the mother cyst, *i.e.*, as consisting of a very thin cuticula, bearing on its outer surface a cellular layer corresponding to the endocyst.

In consequence of its extremely fragile character, it usually happens that, in specimens submitted to ordinary microscopical examination, the brood-capsule is absent, and hence its very existence was unobserved by the older zoologists, and to von Siebold is due the honor of its first recognition.

It appears pretty certain, however, that echinococci are always produced from these structures, and in no other way. The number of echinococci produced by the individual brood-capsule may range from one to a dozen or more, and as the brood-capsules may be produced in very large numbers, it follows that the total number of echinococcus-heads in a large hydatid cyst may reach the number of tens of thousands.

One of the peculiarities of the Echinococcus cyst is the late development of the brood-capsules, and their contained heads, as compared with the formation of the scolex in Cysticercus and Cœnurus. It is common to meet with primary hydatids, as large as a pigeon's egg, in which the scolex formation has not yet commenced.

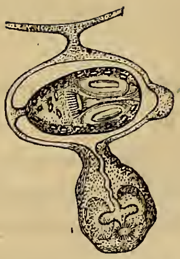


Fig. 62.—Brood-capsule with one inverted Scolex and two externally attached Scolex-buds, in different stages of development. (After Leuckart.)

Fig. 63.—Brood-capsule showing several Scolices (Echinococci) in various phases of development. (After Leuckart.)

The Echinococci—Echinococcus-Heads or Scolices—as they usually present themselves to the observer, consist of minute granular bodies, floating in the fluid of the cyst, or aggregated in patches on its inner surface. These sand-like particles, when placed under the microscope, resolve themselves into collections of smaller or greater numbers of *echinococcus-heads*, sometimes enclosed in a delicate membrane—the *brood-capsule*—at other times presenting some resemblance to a bunch of grapes, attached by their short stems to a common central mass.

The individual scolices are rounded or oval bodies, which, however, may present great varieties in shape under different circumstances. They measure from $\frac{1}{200}$ to $\frac{1}{80}$ of an inch in length, according to their state of contraction.

Usually the Echinococci appear under the microscope with the circlet of hooks and the four suckers enclosed within the rounded outline of the little body, as in Figure 64, but occasionally these parts are seen protruded, as in Figure 65. Busk was of opinion that the Echinococcus-head was never found with the hooklets protruded, unless "When the

Fig. 64.—Echinococcus Scolex as usually seen, with the circlet of hooks, and the suckers withdrawn inside the general body. (After Leuckart.)

Fig. 65.—Echinococcus-head with the rostellum, circlet of hooks, and suckers protruded. (After Leuckart.)

"animal has been spontaneously detached, and perhaps farther "developed, or as the effect of changes indicative of commencing "decomposition."*

It is, of course, a matter of common observation that echinococci are almost always seen with the hooklets and suckers withdrawn, but it must be recollected that when these animals come under examination, they are not seen under their normal conditions; for when enclosed in their parent vesicle within the body of their host, they are not subjected to the mechanical pressure of the cover glass of a microscope slide, and they dwell in a medium of the temperature of the blood (about 100° in man).

At any rate, it may be observed that when a slide, upon which living Echinococci are placed in their native fluid, be gently warmed over a spirit-lamp, the Echinococci exhibit very active movements and protrude their anterior extremities freely.

Perroncito observed also in Cysticerci, under microscopic examination, that they exhibited very active movements when the slide was warmed to about 100° F.†

It is therefore probable that Echinococci, when living under their normal conditions, have their anterior ends as often protruded as not.

When fully extended, the Echinococci are divided by a sort of groove into two parts of nearly equal size. One posterior and more slender, which was considered by Livois to be its caudal vesicle; the other anterior, and more swollen, upon which are placed the important organs of the little animal, viz., the hooks and suckers; and this he regarded as the head of the worm.‡

Now, although the posterior part of the Echinococcus permits the anterior segment to be retracted within it, in the same way as the caudal vesicle encloses a Cysticercus, yet the resemblance between these structures is only a superficial one, for the hinder segment of the Echinococcus' head enters into the formation of the future Tapeworm, quite unlike the caudal vesicle of Cysticercus, which undergoes digestion; moreover, the development of the two structures is entirely different.

At the posterior end of the hinder segment there is seen a notch,

* Transactions of the Microscopical Society, London, November 13th, 1844.

† See Cobbold. Parasites, p. 68.

‡ Livois. Recherches sur les Echinocoques. Paris, 1843.

which receives the little pedicle by which the echinococcus was attached to the germinal membrane from which it sprang.

At the anterior end of the echinococcus is found a single or double circlet of hooklets, from twenty to thirty in number. When a double series is present, the hooks of the two rows alternate—

" A delicate longitudinal striation, as if produced by muscular fibres, " extends from the circlet of hooks through the anterior portion, be- " coming spread out and lost in the posterior "* (Huxley).

The author, also, has observed in living echinococci a striated appearance, most marked between the suckers, and extending in a fan-shape anteriorly.

The posterior part of the little head has a more granular appearance, and is more abundantly supplied with calcareous corpuscles than the anterior one.

In the ordinary retracted condition, the echinococcus-head has a more or less rounded shape, and then, at the point opposite to the attachment of the pedicle, there can be seen a more or less well-marked depression, which points out the spot where the anterior half became retracted within the posterior. Below this are seen the suckers, and still lower down, the circlet of hooks, all of which are plainly visible within the transparent substance of the head.

The points of the hooklets are directed upwards and outwards, and thus the circlet of hooklets stands in the same relative position to the suckers as when the head is protruded.

The Hooklets differ from those of the adult Tænia in the shortness and more slender form of the root-processes. The maximum length of those of the first row is about 0·03 Mm.; those of the second row are somewhat shorter.

Behind the circlet of hooks are found the four *suckers;* they are placed, equidistant, around the circumference of the anterior part of the body.

In their ordinary condition, they present no details of structure, but appear to be homogeneous.

According to Huxley, however, under the action of acetic acid, a radiated fibrillation frequently becomes visible in them.

Calcareous corpuscles are numerously scattered throughout the

*Op. cit., p. 112.

parenchyma of the animal, and with especial abundance in the posterior half.

Vascular System.—Leuckart says, that in favorable specimens, there may be seen four serpentine longitudinal vessels, which, before their entrance into the stem, join into a pair, and which are connected together by a circular anastomosing branch beneath the circlet of hooks. See Fig. 65, page 64.

Huxley was unable to discover any such vessels, but succeeded in convincing himself of the presence of cilia, which usually characterise the water vascular system, when present.

Ordinarily these vessels are not seen.

Professor Owen described echinococci from the pig as moving "freely by means of superficial vibratile cilia" in the fluid of the parent cyst, but no other observer bears out this assertion.

Daughter Cysts—Secondary Cysts.—In many cases of hydatids, the mother or primary cyst contains, in addition to brood capsules and echinococci, a variable number of smaller or larger so-called *daughter cysts*, which float freely in the fluid of the mother vesicle.

In the lower animals, as a rule, these secondary cysts are either wanting, or exist but in small numbers; hence many observers have held the opinion that there were two or more species of hydatid. Thus, at one time, even von Siebold recognised two species, Echinococcus hominum and Echinococcus veterinorum; Küchenmeister also distinguished two species, E. altriciparieus, and E. scoliciparieus; and yet, curiously enough, he objected to the formerly usual division into E. hominis and E. veterinorum, and he remarks on this point—

> "This is incorrect, for Haubner and Creplin have ascertained the "occurrence of E. hominis in cattle, and, on the other hand, von Ammon "has found E. veterinorum in the human eye; and from Eschricht's "description of the echinococcal disease in Iceland, it appears, also, that "in that island both species occur in the human subject."

The views of this observer will be referred to at a later period, but they are mentioned here simply from the fact that this division of species was based, in part, upon the presence or absence of secondary vesicles.

As has been already mentioned, daughter cysts may be entirely

absent, or they may be present literally in hundreds, perhaps thousands.*

They vary, not only in number, but also in size, for they may be barely visible to the naked eye, or as large as a hen's egg.

In all essential respects, their structure resembles that of the mother cyst, for they have a striated cuticula, lined inside by a germinal membrane, and they are capable of developing echinococci in their interior in the same way.

If these vesicles be examined while floating in the clear fluid of their parent cyst, or in salt water of equal specific gravity, it will be seen that, inside their transparent cuticula, there is a germinal layer, which does not appear to be distributed with equal thickness in all parts of the little vesicle, for here and there more opaque patches are seen, with intermediate clearer portions.

Lebert found, in some instances, the remains of a pedicle, leading to the natural conclusion that these free vesicles were once attached to the endocyst of the maternal cyst.

The mode of formation of these structures will be hereafter referred to, in connection with the development of the hydatid cyst.

The Hydatid Fluid.—In its normal condition, *i.e.*, during the lifetime of the parasite, this is a colorless transparent fluid, possessing certain characteristics by which it may readily be distinguished from all other fluids, normal or morbid, of the body.

Although, at first sight, it appears as clear and transparent as water, yet, upon examination by transmitted light, it is seen to be faintly opalescent. Usually neutral in reaction, it may be faintly acid or alkaline. It is of low specific gravity.

According to	Frerichs and Schmalfuss	1,000
"	Bœdecker	1,010
"	Sommerbrodt	1,011
"	Munk	1,012
"	Recklinghausen	1,015
"	Folwarzny	1,015

Its most important chemical properties, practically speaking, are

* Ploucquet cites Allen, who had seen one case where seven to eight thousand, and another where nine thousand, daughter cysts were found. Instances where hundreds are present are by no means rare.

that it contains either no albumen, or only a trace of it, and that it contains a relatively large amount of chlorides, chiefly as sodium chloride. Hence it does not coagulate, or yield a precipitate, by heat or nitric acid, and it gives a copious white precipitate with solution of silver nitrate.

Constituents of Normal Hydatid Fluid.

Percentage of	Hayem.	Jacobson.	Munk.	Wyss.	Heintz.	Scherer.*
Water	97·9	—	98·426	98·59	98·676	93·476
Solid constituents ..	2·3	—	1·574	1·410	1·324	6·523
Consisting of—						
Organic matter....	—	—	0·606	0·546	—	—
Sugar............	—	0·060	0·06	0·027	—	—
Leucin	—	considerable amount.	—	—	—	—
Succinic acid	—	0·700	uncertain.	—	0·341	—
Inosite	—	—	—	0·041	—	—
Urea .... / Creatin	—	—	uncertain amount.	—	—	—
Mucus	0·18	—	—	—	—	—
Albumen	0·4	—	—	—	traces.	—
Inorganic matter ..	—	—	0·968	0·864	—	1·061
Sodium chloride ..	0·53	0·6140	0·61	0·482	0·385	—
" phosphate		—	traces.	—		
" sulphate	0·7	—	—	—	0·90	—
" carbonate		0·230	—	—		

According to Frerichs, the solid constituents amount to 1·41 per cent.; according to Bœdecker, to 1·60 per cent.; and according to Recklinghausen to 2·0 per cent.

Rosenstein and Jæger regard traces of albumen as normal.

Sodium chloride is present in large amount.

Leuckart was of opinion that sugar, when present, was derived from the liver, and consequently was found only in hepatic cysts, but, on the other hand, Wilde found this substance present in the fluid of a spleen hydatid.

In degenerated cysts cholestearin is abundantly found, and

* Scherer's analysis was made upon the fluid of a hydatid of the kidney, but as "it was of a "brownish yellow color, threw down a light flocculent brown deposit, and evolved an ammoniacal "odor," it cannot be regarded as a very trustworthy analysis. *Vide* Animal Chemistry, by Dr. J. Franz Simon. Sydenham Society's Translation, Vol. ii., p. 485.

indeed may be seen, microscopically, in its usual tabular crystalline form.

Hæmatoidine crystals have also been found; they are probably the result of the entrance of more or less blood into the hydatid fluid.

In a case observed by Barker, there were found in a kidney hydatid, crystals of uric acid and of oxalate of lime.

Although the amount of organic matter in hydatid fluid is but small, yet it is amply sufficient to render it very easily putrescible, by exposure to the ordinary atmospheric conditions for two or three days in warm weather.

The preceding description applies only to the living and healthy hydatids. From various causes, very considerable changes may occur, having as their results the death of the parasite, and great alterations in the characters of the cyst wall and contents.

THE LIFE-CYCLE OF ECHINOCOCCUS.

The method of experimental feedings, instituted by Küchenmeister, was soon brought to bear upon the genetic history of Echinococcus, and the result of the experiments of von Siebold, Leuckart, van Beneden, Naunyn, Nettleship, and others, has been to demonstrate, beyond all question, that the cystic parasite known as the "Hydatid," Echinococcus or Acephalocyst, is the bladder-worm stage of a minute cestoid worm (Tænia echinococcus), whose usual habitat is the upper part of the small intestine of the dog.

To clearly demonstrate the life-cycle of any cestoid, two classes of experiments are needed.

1st. To show that a given definite adult Tapeworm can be bred in the alimentary canal of a suitable host, when the latter is fed with living examples of the bladder-worm:

2nd. That when the ova, living embryos, or proglottides of that Tapeworm are, in turn, administered to a natural host of the bladder-worm form, the latter is found to be bred.

In order that such feeding experiments shall succeed, a number of precautions must be observed.

The parasitic forms used as food must be *alive*. If a Hydatid be given to an experimental dog, it is necessary that it should contain living Tænia heads. It follows that Hydatids containing only daughter cysts, but in which no scolices can be found, are very likely to give negative results. Then, again, it is probable that the scolices, even when present in a hydatid, retain their vitality only for a limited period after the removal of the cyst from its host.

What the extreme limits of this period are is not known, but the term is probably affected considerably by external influences, *e.g.*, by the integrity or rupture of the cyst, the temperature of the air, the putrescence of the cyst, &c.

Huxley examined some Hydatids procured from the liver of a zebra, which had died from an accident at the Zoological Society's Gardens, London, and found "that the Echinococci "were in full life, and remained so for three days, until, in fact, "the fluid in which they were contained had become slightly "offensive."*

As regards the Echinococci of man, the author has observed that the scolices may retain their vitality for at least sixty hours after their removal from the body of their host. In the instance in question, he removed about two ounces of clear Hydatid fluid from the liver of a woman, which were set aside in an ordinary test tube, and protected from the access of dust. A microscopic examination was made sixty hours later, and it was observed that when the Echinococci were warmed to a temperature of 100° Fahr., by means of a hot stage, they displayed very active movements, lasting for several hours. It should be added that this observation was made during the winter, in South Australia.

According to the experiments of Professor Perroncito, the scolices of Echinococcus cysts die generally between 47° and 48° C., and in no case experimented upon by him did any reach 50° C. alive.†

This point has an important practical bearing, inasmuch as the thermometer exposed to the sun's rays, during the summer in South Australia, often rises to 160° to 168° F. (= 71° to 76° C.) It follows that ruptured cysts containing scolices will soon perish

* Loco cit. page 111. † Cobbold. Parasites. p. 69.

when subjected to prolonged exposure to the mid-summer sun in this country.*

It is probable that many of the unsuccessful feedings owe their failure to the circumstance that living scolices were not administered. Another source of error is the difficulty of ensuring the absence of a prior accidental infection. To obviate this, usually sucking puppies or lambs have been made use of.

Finally, the examination of the animals experimented upon must be conducted at a suitable time; thus von Siebold was unable to find any Tænia Echinococcus fifty-three days after the date of feeding a dog.

In the case of the proglottides of Tænia Echinococcus, no data exist by which an opinion may be formed as to the duration of their vitality after they have left the intestine of the host.

As regards the ova and their contained hexacanth brood, it is probable that there is great tenacity of life.

Indeed, the distribution of the ova is probably occasioned largely by the influence of winds, which carry these minute bodies from the surface of the soil, upon which they are originally deposited with the excrement of the infected dog, until they find access to surface or swamp water, or to tank or reservoir water. When this water is drunk by man, and the domestic herbivora, the

* The following extract from the *South Australian Register* of January 1st, 1882, gives an idea of the very high temperature occasionally prevailing in South Australia.

The Temperature.—On referring to our "Meteorological Table," it will be observed that the maximum temperature registered at the Observatory yesterday at 3 o'clock, for the previous twenty-four hours, was 112° Fahr. in the shade, 180° in the sun. The latter is the highest, without exception, hitherto recorded. The maximum in the shade was 116·3° on January 26th, 1858.

Hot Days.—We have been favored by Mr. C. Todd, C.M.G., with the following table, showing the dates of exceptionally high temperatures since 1858:—

Date.	Maximum in Shade.	Maximum in Sun.	
		Blk. Glass Bulb.	Lamp blk. Bulb.
January 26, 1858	116·3	—	—
January 21-22, 1860	113·7	—	—
January 9-14, 1862	115·0	166·0	—
November 21, 1865	113·5	—	—
January 11, 1867	—	164·0	—
January 12, 1867	113·5	—	—
December 14, 1876	114·2	—	—
January 10, 1878	114·3	165·0	172·9
January 29, 1879	114·2	—	—
January 5, 1880	—	162·5	171·0
January 20, 1880	114·5	163·0	172·0
December 30, 1880	—	158·5	168·0
January 7, 1881	—	159·0	169·0
January 18, 1882	112·0	168·5	180·0

minute ova (measuring only $\frac{1}{370}$ inch), pass unnoticed into the stomach.

It is probable that, practically speaking, the infection of man with echinococcus is produced almost exclusively by his drinking-water.

This subject is discussed at length in a later part of this work.

Upon the Breeding of the Tænia Echinococcus from Hydatids.—The first experimental feeding of Echinococcus was made by von Siebold in 1852, and he was followed shortly afterwards by Küchenmeister and others.

*The Feeding Experiments of von Siebold.**—After this able zoologist had succeeded in breeding in the intestine of the dog the cestoid Tænia Serrata from the cysticercus of the rabbit, it occurred to him to administer the living Echinococcus veterinorum of domestic cattle to dogs. This was done by mixing the echinococcus heads, procured from fresh cysts, with luke-warm milk and pouring the mixture down the throats of the dogs experimented upon; a supply of warm milk was then allotted to each animal, which was usually greedily licked up by them, and so the conveyance of the Echinococcus-heads into the stomach was ensured. A considerable number of experiments were made, of which the following were briefly the results:—

No. 1.—A young dog, of no breed in particular, received, on May 22nd, 1852, a considerable dose of echinococcus brood and milk. On June 3rd, *i.e.*, twelve days after the feeding, the dog was killed with chloroform, and the body was immediately examined.

The stomach contained no trace of worms, but in the mucus of the entire small intestine there were found innumerable echinococcus-larvæ, all of which had their heads protruded. Usually, they were found with their heads hidden between the villi of the intestine, and, on account of their small size, they could be recognised only by the use of a magnifying glass, in the mucus scraped off by the back of a scalpel.

In none of the small larvæ (as von Siebold calls them) could any segmentation be discerned.

*Uber die Verwandlung der Echinococcus-Brut in Tænien. Zeitschrift für Wissenschaftliche Zoologie. Leipzig, 1853, p. 409.

They exhibited the well-known scolex form, and contained in their interior the usual calcareous corpuscles, apparently in the same number, and with similar distribution, as in the case of the Echinococcus-heads. No trace of sexual organs existed, but at the posterior end there could be discerned a sphincter-like opening, which, upon closer investigation, proved to be the spot out of which, formerly, the stem-like peduncle had projected, which attached the little Echinococcus-head to its neighbors or to the brood-capsule. All these minute scolex-forms corresponded closely with the Echinococcus-heads from which they had developed, but the extended "neck" part, behind the head proper, was relatively much more slender than in the original Echinococcus. This alteration, according to von Siebold, is obviously due to the circumstance that the Echinococcus-heads, when enclosed in their parent hydatid, are immersed in a fluid of low specific gravity, but when they get into the intestine of their new host they are imbedded in a viscid medium* of higher specific gravity (the intestinal mucus), to which they yield much of their contained fluid by exosmosis, and hence their posterior part shrinks and becomes slender.

Fig. 66.—Earliest stage of development of Echinococcus-heads into mature Tapeworms in the intestine of the dog. (After von Siebold.)

No. 2.—On May 23rd, another young dog was fed in the same way as No. 1. Towards the middle of June, he began to sicken, lost his appetite and frolicsome disposition, became emaciated, frequently whined, had tremor of his limbs, and passed brownish fluid evacuations. On June 14th, *i.e.*, twenty-one days after the feeding, he was destroyed by chloroform (as were indeed all the other dogs experimented upon).

The stomach contained a brownish fluid (probably decomposed blood), the lining membrane of the small intestine was in many places greatly reddened, and it was thickly covered with milk-white projections, presenting an appearance as if the intestinal villi were distended with chyle. By closer investigation von Siebold discovered, to his astonishment, that all these white papillæ were in reality innumerable little Tapeworms, with their

* According to Thiry, the specific gravity of the secretion obtained by isolating a loop of small intestine in the dog, whilst preserving the vascular supply intact, and establishing a fistulous opening in the loop, was 1·0115. But then it must be remembered that the normal conditions are seriously interfered with. See Carpenter's Human Physiology, 8th edition, p. 169.

heads imbedded between the intestinal villi, and their posterior chalky-white segments projecting free on the surface of the mucous membrane. They measured from 1 to $1\frac{1}{2}$ lines in length, and corresponded exactly, as regards their heads, with Echinococcus-heads. Most of them showed two or three joints; others, in a stage of less advanced development, showed, by their non-segmented bodies, their origin from the Echinococcus-heads administered. The posterior joint of this little Tapeworm constituted about half its entire length. The anterior half of the body, in the individuals possessing only two joints, consisted of a head and neck portion. In the three-jointed animals, there was a middle joint, which had not reached the degree of development of the terminal joint. The last joint showed clearly the outlines of the sexual apparatus, and at its distal border in the middle, it showed the sphincter-like opening already referred to.

No. 3.—Another dog was, on June 5th, fed, in the usual way, with a considerable quantity of the mixture, as before.

The result was as successful as in Nos. 1 and 2, when the animal was examined on June 26th, *i.e.*, twenty-two days later.

No. 4.—A young dog received, on June 7th, several thousands of echinococci, and was destroyed on July 3rd, *i.e.*, twenty-six days after his meal of hydatids. The stomach, as usual, contained no worms, but the entire mucous membrane of the small intestine, from the pylorus to the duodenum, was thickly beset with minute Tapeworms, $1\frac{1}{2}$ lines in length, very much in the same way as in No. 2.

They had, nearly all, three segments, and they quite corresponded with those found in No. 2. Many of the little Tæniæ had lost their circlets of hooks, an occurrence not uncommon in all armed Tapeworms. The sexual organs were plainly distinguishable in the third joint, and von Siebold thought that he could see traces of ova in an early stage of development.

No. 5.—In order to see, in the shortest possible time, the Echinococcus larvæ developed into fully-formed and sexually ripe Tapeworms, the dog, in this experiment, was fed with the immature worms obtained from experiment No. 2. These were administered, as usual, with milk, to a young poodle. Five days after this second feeding, and twenty-seven days after their administration to the first dog (No. 2.), the poodle was destroyed, and many of the

Tapeworms were again found. By this time, although they still had only three joints, and had not notably increased in size, they were evidently fully grown and sexually ripe, for their last joints contained ripe ova, which enclosed in their interior the well-known six-hooked embryo. The cirrus and coiled vas deferens were also present; even spermatozoa were seen. In the middle joint, traces of the sexual apparatus could be recognised, and the contained ova were evidently unripe. The first segment (or Head-joint) showed, a little posterior to its middle, a narrowing, which, however, was not sufficiently decided to produce a second joint, but yet indicated its formation. Many of the individuals had lost their hooklets, which von Siebold regarded as an indication of maturity.

No. 6.—Another portion of the young Tænia brood procured from No. 2 was administered, on June 14th, to a young fox. On August 27th, *i.e.*, seventy-four days after the feeding, the animal was killed, but no trace of Tænia Echinococcus could be discovered. It contained only several small individuals of Tænia Cucumerina, some specimens of Ascaris Triquetra, of a species of Strongylus and of Holostomum Alatum.

No. 7.—Another poodle which, on June 19th, had swallowed an abundant portion of Echinococcus larvæ, with milk, became ill soon after the feeding, and eight days later (on June 26th) was killed. His small intestine contained many Tæniæ Echinococcus, of which only a few appeared to have enlarged in size.

No. 8.—On the same day, June 19th, a young hound obtained a considerable dose of milk and Echinococcus. This dog was, on August 10th, *i.e.*, fifty-three days after the feeding, examined, but no trace of Echinococcus larvæ or Tæniæ could be found.

No. 9.—A mongrel dog was, on June 18th, fed in the usual way with Echinococcus and milk, and was killed on July 25th, *i.e.*, thirty-seven days after his experimental meal. The first half of the small intestine contained innumerable Tæniæ Echinococcus. They all had two joints behind the head, and the majority also showed the partial segmentation of the head-joint noticed in No. 5. The last joint showed the usual signs of sexual ripeness.

No. 10.—A third young poodle, which, on the 18th of June, had swallowed many hundreds of Echinococcus-heads in milk, was examined on the 4th of August, forty-eight days after. In his small intestine were found more than 100 individuals of Tænia

Cucumerina, of different sizes, five specimens of Ascaris Marginata, and several of Strongylus Trigonocephalus, and, in addition, very many Tæniæ Echinococcus of $1\frac{1}{2}$ lines in length. These presented, in their middle joints, traces of the sexual apparatus, and in the last joint these organs were fully formed, and contained unripe ova.

No. 11.—A mongrel was compelled to swallow, on August 8th, a considerable quantity of Echinococcus brood. Two days later the animal fell ill, with loss of appetite and wasting. It was destroyed on August 23rd, and his small intestine was found to contain several large specimens of Ascaris Marginata, and some individuals of Tænia Cucumerina, but no trace of Tænia Echinococcus.

No. 12.—On August 14th, a young dog received the usual dose in large quantities. It also became ill, and was found dead on the 21st August. In the stomach were found three large specimens of Ascaris Marginata. The intestine contained no trace of Echinococci.

No. 13.—A young mongrel was also, on August 14th, fed with the usual mixture. It commenced to get ill soon after the feeding, and was found dead fifteen days later, on August 28th. The small intestine contained, besides a reddish-brown watery fluid, two examples of Ascaris Marginata, one small Tænia Cucumerina, and many, chiefly dead, Tæniæ Echinococcus. The latter possessed only a single joint behind the head, and in this no trace of the sexual organs existed.

In all these *post-mortem* examinations the contents of the large intestine were also examined, but there were never any Echinococcus larvæ or Tæniæ found in this part of the alimentary canal.

It is to these decisive experiments, made by von Siebold, that modern helminthology owes its knowledge of the co-relative Cestoid form of Echinococcus.

It was only after von Siebold had bred, described, and named Tænia Echinococcus, that it was noticed that the same Tapeworm had probably been observed by Rudolphi, Röll, and van Beneden, and had been regarded by them as a juvenile form of other Tapeworms.

According to these experiments, the Echinococcus brood develops into sexually ripe Tapeworms shortly after the twenty-second day. On the twenty-seventh day, the embryo is distinguishable in the ova. At this time, too, many of the Tapeworms

have lost their hooklets; which von Siebold regards as a sign of senile decay.

In two of the experiments, *i.e.*, Nos. 6 and 8, no Tænia Echinococcus was found, and as its absence could not be explained by the occurrence of any sickness in the animals (a dog and a fox) experimented upon, von Siebold believed that the examinations were made too long after the dates of the feedings. In No. 6, the fox subjected to experiment was examined seventy-four days after its feeding. In No. 8, the period was fifty-three; von Siebold believes that the sojourn of Tænia Echinococcus in the intestinal canal of the dog is usually only a brief one, not exceeding two months.

In Nos. 11 and 12, no Tænia Echinococcus was found sixteen and eight days respectively after the feeding, but, in these cases, the failure may reasonably be attributed to the serious illness of the animals experimented upon.

In two of the cases (Nos. 2 and 7) it is true that the animals experimented upon became sick and yet the feedings were successful; but, in these instances, the dogs were not so violently ill as in the cases previously mentioned as unsuccessful.

Von Siebold remarks that the illness of the dogs could not be attributed to the presence of the Tænia brood in the intestine, otherwise, in experiments Nos. 3, 4, 5, 9, and 10, where such vast numbers of the Tapeworms were found, the dogs would have been ill also.

According to Leisering, Bollinger,* and Pillwax, dogs highly infested with Tænia Echinococcus suffer, not only from a hæmorrhagic inflammation of the mucous membrane of the intestine, but also from symptoms closely resembling rabies. This statement is by no means supported by the experimental feedings of von Siebold, nor by the personal observations of the present writer. The latter has, on many occasions, found thousands of these minute Tapeworms in dogs that did not show the smallest appearance of ill-health of any kind. It is possible, however, that the first onset of infection may produce symptoms not present at a later period.

Many continental observers, including Haubner, Leuckart,

* Virchow and Hirsch's, Jahresbericht über die Leistungen und Fortschritte in der Gesammten Medicin, for 1877, p. 600.

Küchenmeister, &c., have confirmed the experiments of von Siebold, as regards the hydatids of the lower animals.

In England, a very successful experiment of the same kind was made by Nettleship, in 1866.*

It is described as follows:—

"On March 28th, 1886, I obtained from Clare Market the liver and "lungs of a sheep containing numerous Echinococcus Hydatids; in some, "the outer cyst was partly calcified, but in all, the hydatids contained "clear fluid, and great numbers of Scolices attached to the endocysts. "Within two hours of the death of the sheep to which the organs be-"longed, I gave two or three of the smaller hydatids to a young dog, "about six months old, first puncturing the hydatid, and administering "the collapsed cyst, and then making him drink the fluid of the cyst, "in which some Echinococci were floating.

"The next day I gave him a second feeding of the remaining "Hydatids; this second batch he threw up within half an hour of the "feeding, but he afterwards swallowed the broken membranes again "and did not afterwards vomit. I was careful to administer the "Hydatids from both calcified and non-calcified cysts.

"The animal remained perfectly healthy, and became very much "fatter; he was fed for the most part on cooked kitchen refuse, but I "cannot be positive that he never obtained any raw food.

"On May 15th (the forty-seventh day after the first feeding), I killed "the animal, and examined the intestines. In the first ten inches of bowel, "below the pylorus, there were no Tæniæ; at that distance a single "Tænia Echinococcus appeared, moving actively; for the next two or "three inches, there were none, but at about fourteen inches below the "pylorus, several more appeared, and immediately after this they became "so numerous as to present almost the appearance of distended lacteals: "this continued for about a foot in extent, and then they became gradu-"ally less numerous, and ceased at about three feet from the pyloric "orifice.

"There were also four specimens of Tænia Marginata, varying from "two to three feet in length, and two of T. Cucumerina. On $\frac{1}{16}$ of "a square inch, where the worms were thickest, I counted twenty-five "of them; by calculation, there were about twenty-two square inches of "intestine covered in this way, allowing for the more thinly scattered "parts at each end of the infected parts; this gives a total of 8,800 "specimens of Tænia Echinococcus in this dog's bowel."

In the experiments just described, the dogs were fed with Echinococci obtained from the *lower animals* (Echinococcus veterinorum).

* Notes on the rearing of Tænia Echinococcus in the dog, from hydatids, with some observations on the anatomy of the adult worm, by Edward Nettleship. Mem. Royal Agric. Coll. Proceedings of the Royal Society, vol. xx., No. 86.

Now, as many able zoologists considered that there were more forms than one of Echinococcus, it became a matter of great importance to determine, experimentally, whether this really were so or not.

Küchenmeister recognised two forms, Echinococcus Scolicipariens and Echinococcus Altricipariens.

His E. Scolicipariens corresponded to the E. Veterinorum of the earlier authors, and he recognised, as its mature cestoid form, the little worm discovered and described by von Siebold as Tænia Echinococcus, but as regards the second form, Echinococcus Altricipariens—E. hominis of other writers—he believed its mature Tapeworm to be quite distinct from Tænia Echinococcus, and to be as yet unknown. He remarks upon this subject :—

" I should not wander far from the truth if I were to assert that this " Tænia may probably occur in the human intestines, and indeed in the " intestines of those individuals who suffer, or have suffered, from the " species of Echinococcus belonging to it in some part of their bodies, " and in whom such a colony of Echinococcus has opened towards the " intestine."*

He was also of opinion that the adult Tænia might develop itself in the intestines of domestic carnivorous animals, especially in cats and dogs. In justice to this gifted zoologist, however, it must be mentioned that he subsequently accepted the more modern view of the unity of species of Echinococcus.

Both Küchenmeister and Zenker endeavored to breed the adult Tapeworm from Echinococci derived from man, but without success. In 1863, however, Naunyn, at Berlin, as well as Krabbe and Finsen, in Iceland, succeeded in breeding Tænia Echinococcus from hydatids derived from man.

Krabbe's and Finsen's Experiments.†—*No.* 1.—In the Autumn of 1862, M. Finsen sent to M. Krabbe a glass containing Tæniæ found by him in the intestines of a young dog, to which, some months previously, he had administered Echinococci obtained from a patient operated on by Recamier's method.

The Tapeworms submitted to M. Krabbe were chiefly specimens

* On Animal and Vegetable Parasites of the Human Body, by Dr. Frederich Küchenmeister. Sydenham Society's Translation, 1858. Vol. i., p. 205.

† Recherches Helminthologiques en Danemark et en Islande, par H. Krabbe. Copenhagen 1866, p. 49, et seq.

of Tænia Cucumerina, but there was found, also, one mature joint of Tænia Echinococcus.

This case is not entirely satisfactory, since no mention is made of any precautions taken to prevent infection of the dog in question from other sources than the experimental feeding, and as dogs in Iceland are very frequently infested with Tænia Echinococcus, the experiment cannot be regarded as decisive.

No. 2.—On the 26th February, 1863, there died, at the hospital of the Commune, a woman aged thirty-seven, who, for a year past, had suffered from a considerable swelling of the abdomen. At the *post-mortem* examination, there were found in the liver and spleen a great number of Hydatids, both with and without secondary Hydatids; many were also found to contain Echinococcus-heads.

On the 28th of February, some of them were administered to a cat, and to a dog from three to four years old, and on the 1st March to a second dog of the same age.

The first dog was killed on March 29th, *i.e.*, on the thirtieth day after the feeding: Ten specimens of Tænia Cucumerina only were found by Krabbe. The cat, which was examined on April 11th, had, in its intestine, ten specimens of Tænia Elliptica and two of Ascaris Mystax, and the second dog, which was destroyed on April 24th, *i.e.*, fifty-five days after the feeding, contained no intestinal worms. No Tænia Echinococcus was found in any one of these animals.

No. 3.—On the 2nd of July in the same year, Dr. Hjaltelin, at Reykjavik, operated, by puncture, upon a man aged twenty-six, who for thirteen or fourteen years had suffered from a Hydatid tumour in his right hypochondrium. Two and a half litres (about eighty-eight fluid ounces) escaped. The last portion contained numerous Echinococcus-heads joined into groups, attached to fragments of germinal membrane, and, in some of these heads, distinct, although feeble, movements were observed under the microscope. One hour after the operation, Krabbe gave, in warm milk, about half of these echinococci to a dog, ten days old, a little later the remaining half was administered to a cat, two years old. The dog was killed in seventeen days' time, and, after seventy-seven days, the cat also. Neither contained any Tapeworms.

No. 4.—This experiment is sufficiently important to be given in full detail. The following account of it is given by M. Krabbe.

"On the 8th of August, I examined, at Ofjord, two dogs, each a little "over one year old. M. Finsen had kept them shut up since they had "ceased suckling in order to use them for purposes of experiment. Since "the month of April, they had been able to run about in liberty, but "without being permitted to go to any distance from the house, and they "were submitted to such a close surveillance that M. Finsen was cer- "tain that they had not been able to eat any Echinococci of domestic "animals.

"On April 2nd he had given them Echinococci, obtained from the "abdomen of a man sixty-six years of age, on whom he had operated, "by Recamier's method, upon a tumour which the patient had suffered "from for thirty years.

"These hydatids, which looked quite good, but which had not been "examined under the microscope, formed a mass of about fourteen litres. "Of this, there were administered to each dog two spoonfuls, partly in "milk, partly with the aid of a forceps. On May 1st, they were again "compelled to swallow fragments of an Echinococcus hydatid, obtained "from the pelvis of a woman thirty-four years of age, who had had this "tumour for twelve years, and had been operated upon in the same way. "When the dogs were examined, four months after the first feeding, and "three months after the second one, one of them contained no intestinal "worms, while in the other I found four Tæniæ Canis Lagopodis, and a "tolerably large number of Tæniæ Echinococcus. The latter were from "five to seven Mm. long, and had all the base of the hooklets well de- "veloped. The large hooks measured 0·33 to 0·39 Mm., and the small "ones 0·21 to 0·29 Mm. Some of these worms had three joints, and, in "this case, the last joints did not contain distinct ova, or if they con- "tained any, they had not reached maturity. Other worms possessed "four joints, the last of which contained eggs with solid envelopes. On "the 10th and 11th of August, I gave some of these to a lamb to eat, "and when it was killed, on the 23rd of November, I found, here and "there, in the liver and lungs, small hydatids as large as a pin's head."

No. 5.—On the 12th of the same month, Krabbe examined, at Ofjord, a dog about two months old, which M. Finsen had always kept shut up. Towards the middle of July, M. Finsen had made him eat, four times, at intervals of a few days, fragments of hydatids extracted from a cyst of the liver operated upon by him in a woman forty-five years old, who had suffered from it for five years; a portion of this hydatid was preserved for examination, but no Echinococcus-heads were found on it.

This dog contained no Tæniæ and only one Ascaris Marginata.

No. 6.—On the 12th of September, at Ofjord, M. Finsen caused

two young dogs, which had been shut up since August 15th, to swallow two spoonfuls of hydatids (the dogs were, the one three to four months, the other about six months old). The hydatids administered to them were partly perfect, and partly ruptured; in some samples of the latter he had satisfied himself by the microscope that living Echinococci existed.

The hydatids, which contained secondary vesicles, were obtained from a tumour, situated in the inguinal region of a woman aged thirty-two. The tumour itself was known to have been present for fourteen years, and had been operated on, by Recamier's method. From the 22nd to the 24th of September, there were administered, daily, three spoonfuls of the hydatids, each time with some heads. On the 27th, they were placed on board a ship and forwarded to the Veterinary School at Copenhagen.

On October 29th, *i.e.* thirty-five to thirty-eight days after the feedings, the younger dog was killed, and Krabbe found, besides about four hundred specimens of Tænia Canis Lagopodis, four little Tæniæ Echinococcus, 3·5 to 4 Mm. long, concealed in the villosities of the intestine. They possessed, besides the head, only two joints, in which Krabbe could find no eggs. The hooklets, of which the larger measured 0·023 to 0·025 Mm. long, and the smaller ones 0·015 to 0·019 Mm. long, resembled greatly, both in size and shape, those of the Cystic worm heads.

The second dog, examined on November 22nd, contained no intestinal worms.

These experiments have been referred to in detail, inasmuch as they are of great importance from a biological point of view, but they can scarcely be regarded as altogether conclusive, for, of the six feedings, none are perfectly beyond cavil.

In No. 1, there was no satisfactory evidence that living Echinococcus-heads had been administered, and the feeding had taken place "some months previously"; moreover, but one joint of T. Echinococcus was found; finally, there was no evidence that the dog had been protected against other sources of infection.

In No. 2, the experiment yielded negative results. In No. 3, seventeen days after, what appeared to be, an efficiently conducted experiment, no Tæniæ were found.

No. 4 was a far more successful effort, and yet, even there, no result whatever was yielded by one of the two dogs, although both were fed in precisely the same way, at the same time, and upon the same hydatids. In the other dog, it is true, a large number of Tæniæ Echinococcus were found, but, in addition, there were four specimens of T. Canis Lagopodis, of whose origin no account can be given.

In No. 6, of two dogs fed, one was killed seventy-one days after a carefully-conducted feeding with live Echinococcus-heads, and no intestinal worms were discovered; this may, however, be explained by von Siebold's statement, that Tænia Echinococcus has usually only a short sojourn in the dog's bowel.

In the case of the second dog, 400 specimens of Tænia Canis Lagopodis,* and only four of Tænia Echinococcus, were found.

This reminds one of Falstaff's hotel bill: "But one half-penny "worth of bread, to this intolerable deal of sack."

No. 5 experiment must be regarded as negative in every way.

Fortunately, an experiment made by Naunyn,† in Berlin, supplies confirmatory evidence of a less questionable nature.

On February 17th, 1863, this observer administered to two dogs the contents of a hydatid of the liver which contained Echinococcus-heads, and which had been obtained from a woman operated on by puncture of the cyst.‡

One of the dogs, which was destroyed and examined twenty-eight days subsequently, contained no intestinal worms. But in the second one, Naunyn found, on the thirty-fifth day after the feeding, examples of Tænia Echinococcus, from 1 to $1\frac{1}{2}$ lines long, whose last joints contained eggs enclosed in a membranous envelope.

---

* Tænia Canis Lagopodis. Krabbe found this parasite present in more than one-fifth of all the Icelandic dogs (over 100 of all ages) examined by him. It seems to be a peculiar species, whose genetic history is not yet known. Krabbe and Cobbold regard it as identical with the Tænia Litterata of Batsch. Be that as it may, its frequent presence in Icelandic dogs seriously vitiates the results of these experimental feedings.

† Reichert und DuBois-Reymond. Archiv für Anatomie, Physiologie, und wissensch Medicin, 1863. Heft iv., p. 412. "Ueber die, zu Echinococcus hominis, gehörige Tænie." Von Dr. B. Naunyn.

‡ In the majority of Krabbe's experiments, Recamier's caustic treatment was employed in the cases from which the feeding hydatids were obtained, and this may, perhaps, have, in some cases, acted injuriously upon the vitality of the hydatids.

The characters of the hooklets quite corresponded with those described in Krabbe's sixth experiment, which were present at just the same period after the feeding, *i.e.*, the thirty-fifth to the thirty-eighth day. Finally, in the third joint, the generative organs were present, precisely as described by Leuckart, &c.

Upon the Specific Identity of the Various Forms of Echinococcus.—Now, although the evidence supplied by the feeding experiments of Naunyn and Krabbe is not in itself beyond cavil, yet, viewed in the light of the well-established experiments of von Siebold, Küchenmeister, Nettleship, and others, made with the Echinococcus of sheep and cattle, it may fairly be concluded that the Echinococcus of man, when it obtains access under favorable circumstances into the alimentary canal of the dog, develops there into a cestoid form quite similar to, and indeed identical with, that obtained by the administration of the Echinococcus Veterinorum to dogs, and the hypothesis of Küchenmeister, that the types E. Altricipariens and E. Scolicipariens are specifically distinct, and have distinct cestoid forms, is no longer tenable.

Moreover, no hard and fast line exists between the forms E. Altricipariens and E. Scolicipariens, for we may have very many, very few, or no daughter vesicles in any given cyst, and instances* have been recorded where, in the same host, cysts were found, some of which contained daughter cysts, and others were solitary. Küchenmeister based his views of the specific difference between E. Altricipariens and E. Scolicipariens, not merely upon the difference in the process of proliferation, but also upon the circumstance that the two kinds present striking distinctions in the number, size, and shape of the hooklets. According to him, Echin. Scolicipariens has twenty-eight to thirty-six hooklets of blunter shape, whilst Echin. Altricipariens possesses between forty-six and fifty-six of more slender figure and of smaller size. These differences depend, however, as R. Leuckart points out, partly upon the age of the bearer, and also in part upon the circumstance that great individual differences exist in the number and arrangement of these structures.

---

* Davaine records such a case occurring in the pig.

The Anatomy of Tænia Echinococcus.—Tænia Echinococcus is a Tapeworm of minute size, having only three or four segments; the most posterior joint, when in a state of sexual ripeness, exceeds in size the remaining part of the body. The entire length of the adult animal does not often exceed five millimetres, *i.e.* about $\frac{1}{5}$ of an inch. The writer has met with instances in Australian dogs where Tænia Echinococcus has reached the length of $\frac{3}{8}$ of an inch, but the usual length did not exceed $\frac{1}{4}$ inch. The head is provided with a prominent rostellum, at the base of which there is a double row of hooklets. The hooklets are thirty to forty in number, and possess well-developed root-processes.

This little parasite in its cestoid phase inhabits the small intestine of the dog, jackal (Panceri), and wolf (Cobbold).

Fig. 67.—Tænia Echinococcus. (After Cobbold.)

The head is very small, measuring in transverse diameter only 0·3 Mm., and from its vertex springs the projecting rostellum, which the worm has the power of retracting within its head, together with its circlets of hooks.

The hooklets form a double row, each containing fourteen to twenty-five members. After the death of the animal they very easily drop off, consequently the worm is commonly found quite bald of hooklets.

The hooklets of the adult worm differ from those of the Echinococcus-heads only in the degree of development, especially of the root-processes, and this is due, as Leuckart has pointed out, to the circumstance that the Echinococcus hooklets acquire their full development only during the conversion of the cystic into the sexually ripe cestoid worm.

Even when the hooklets of the same phase of development are examined, great varieties in shape are seen, as Krabbe has depicted. (See Fig. 68.)

Fig. 68.—Various forms of hooklets of Echinococcus and circlet of hooks of Tænia Echinococcus. (After Krabbe.)

The hooks of the anterior row are the larger, and attain, in their fully-developed condition, a length of from 0·040 to 0·045 Mm. The hooks of the second series are from 0·030 to 0·035 Mm. long, they are also more slender in form, especially as regards the posterior root-processes.

Behind the rostellum and circlet of hooks are to be recognised the four suckers, about 0·13 Mm. in diameter, and behind these, the head shades off into a neck.

The first succeeding segment is only slightly defined, and is scarcely wider than the part of the neck adjacent to it. It has a length about equal to its breadth.

The second segment is about twice as broad, and four times as long, as the one in front of it. In this, there are discernible male and female generative organs, a marginal cirrus, seminal duct, and ova. The latter are collected together into the uterus, and they occasionally show indications of embryonic development. The third and last joint shows all the signs of so-called ripeness, for not only has it attained a length of two Mm. by a width of 0·6 Mm., but it also contains hard-shelled eggs, which enclose the well-known hexacanth embryos; they amount, according to Johne and Küchenmeister, to about 500 in number.

The shape of the uterus is simple. It consists of a median trunk, with faintly ramified lateral appendages.

Although the adult worm is so small, the ova have the usual size of Tænia eggs.

The cirrus is usually found, in the case of the last joint, upon the side opposite to that which the same organ occupies in the last joint but one. In other words, the sexual openings are placed alternately.

Before the last ripe proglottis is cast off, a new joint is formed anteriorly, so that for a certain time, instead of three, there may be recognised four proglottides.

The usual calcareous corpuscles are plainly discernible, especially in the anterior part of the worm.

The water vascular system is well developed in Tænia Echinococcus, and consists of two pairs of laterally-situated vessels, which extend through the entire length of the colony. These are, according to von Siebold, much more easily distinguished in the head end of the worm, where the vessels are joined together by a circular branch, which lies immediately below the circlet of hooks.

This vascular system can be distinguished only in perfectly fresh specimens, and as ciliary movements can be discerned in the living animal, it is probable that the minute vessels of the water vascular system are here, as in other Tæniæ, connected with the funnel-shaped cells described by Pinter* and Fraipont.†

The sexual organs show definite peculiarities, which contribute materially in establishing the specific independence of this worm. Descriptions of the sexual apparatus have been recorded by Nettleship, and in greater detail by R. Leuckart. The exact arrangement of the parts is extremely difficult to make out, and there is not an exact agreement in the statements made by these writers. As regards the male organs, this worm is characterised by an unusually large development of the cirrus-sac, and of the cirrus itself, which, not rarely, is found protruded externally. Leuckart even depicts it, as seen in figure 69, inserted in the adjacent vagina, in the act of copulation.

The vas deferens is described by the same writer as making several irregularly serpentine curves before its entrance into the cirrus-sac.

The testes are globular in shape, about sixty in number, and they measure, on an average, 0·07 Mm. in diameter; they contain spermatozoa of unusual length and thickness.

* Untersuchungen über den Bau des Bandwurm-körpers. Vienna, 1880.

† Recherches sur l'appareil excréteur des Trematodes et Cestoides. Archiv de Biologie. Vol. i.

Fig. 69.—Generative organs of Tænia Echinococcus. (After Leuckart.) *a. a. a.* Testes. *b.* Cirrus-pouch containing penis, which is seen to be inserted into the vaginal entrance near *d.* *c.* Convoluted vas deferens. *d.* Vagina. *e.* Pouch, in course of the vagina. *f.* "Seminal pouch" of Nettleship. *g. g.* Ovaries. *h.* The yelk (?) gland.

The female organs consist of an uterus, ovary, vitelligenous gland, and vagina, but the relations of these several parts can scarcely be regarded, at present, as clearly demonstrated. The most exact description extant is that given by Leuckart. According to that authority, the following is the arrangement of the parts.

The vagina shows, at about the middle of its course, an elongated dilatation, and at its internal extremity terminates in a pouch of considerable size—the *seminal pouch* of Nettleship. Opposite to the opening of the vagina into the seminal pouch there arises a canal, which one may perhaps regard as the continuation of the vagina. This canal, however, soon divides into two narrow branches. Of these, one curves forward, in the shape of a hook, whilst the other continues its course posteriorly ; the former one is the true oviduct, and its anterior end is connected in the usual manner with the two ovaries. The last-named organs are made up of cæcal pouches, which are short and wide, so that the ovaries present rather the appearance of lobulated sacs than acinose glands. In their interior, one can, however, recognise the eggs as sharply-defined little spheres of about 0·01 Mm. in diameter. The second canal splits up again into two passages, of which one passes into the yelk-sac, and therefore is the yelk-duct; the second probably stands in some connection with the uterus. As regards the uterus, this organ appears relatively late, and attains its full development only after the ovary and vitelligenous gland have undergone more or less complete atrophy.

In none of the mature segments was Nettleship able to make out any communication between the vagina and uterus, either in front of, or behind, the seminal pouch.

This is quite in conformity with the arrangement prevalent in the Tæniadæ, in which the ova become released only by the rupture or destruction of the ripe proglottis.

These small Tæniæ are frequently found in large numbers in the upper part of the small intestine of the dog. How numerously they may be found was well shown in the very successful experiments of von Siebold and Nettleship, already described.

Now, if we consider that the number of ova in each ripe proglottis amounts to some hundreds, and, moreover, that it is probable that each adult worm may yield numerous ripe proglottides in succession, then it will be easily understood how, among such vast numbers of ova, some, at least, may, by various favorable accidents, obtain entry into the bodies of suitable hosts, and undergo their cystic phase of development.

These minute Tæniæ, when present in great numbers, offer, at first sight, the appearance of white papillæ upon the surface of the mucous membrane of the intestine, and give the impression that the lacteals of the part are greatly distended. This is due to the circumstance that the Tapeworms lie with their heads deeply inserted amongst the intestinal villi, while their chalky-white posterior proglottides project free on the surface of the bowel.

The worms exhibit very active movements of elongation and contraction, and thus, no doubt, greatly expedite the separation and escape of their terminal ripe proglottides, with the contained ova, and even the recently-detached ripe posterior joints show the same active movements, so that they look like minute round worms.

Although we are indebted to von Siebold for our knowledge of the family history of Tænia Echinococcus, yet the adult parasite was not unknown to other helminthologists. Thus Rudolphi found the same worm in vast numbers in the intestine of a pug, but attributed its presence to spontaneous generation. The same animal was known also to Röll, and van Beneden gives a figure of it in his well-known work,* under the designation of Tænia nana.

The Development of the Hydatid Cyst.—In order to render our knowledge of the life history of Echinococcus complete, it was necessary not only to prove that from the cystic Hydatid, with its contained Echinococcus-heads, there could be

* Mémoire sur Les Vers Intestineaux. Pl. xxi. Fig. 19.

bred the cestoid Tænia, but also that the converse experiment could be successfully carried out.

In the latter problem, R. Leuckart has rendered valuable service to science.

On the interesting questions connected with the development and anatomy of the various products of the mother cyst, *e.g.*, the Brood-capsules, Scolices, Daughter cysts, &c., Leuckart, Rasmussen, Naunyn, Huxley, Busk, and many other observers, have thrown much light.

It will be convenient to consider the growth of the hydatid in three possible stages:—

1st. The stage of **Acephalocyst**.

2nd. That of simple **Scolex-production,** *i.e.*, the so-called Echinococcus Veterinorum, or E. Scoliciparien.

3rd. That of **Nurse-production,** *i.e.*, of the formation of daughter and granddaughter, &c., cysts. We then have the forms known as Echinococcus Hominis or E. Altriciparien.

It must be remembered, however, that some hydatids never pass beyond the first stage; others attain the second, and some reach the third stage.

I. **The Acephalocystic Stage.**—Helminthology is especially indebted to the careful experiments of Rudolph Leuckart, and Haubner, for the knowledge of the early stages of development undergone by the *pro-scolex (boring embryo)* in its development into the complete cystic form.

As has been already mentioned in Part II., the Tapeworm ova, when swallowed by a suitable host, undergo in its stomach a process of digestion, in consequence of which the eggshell (or shells, as the case may be) becomes destroyed, and the contained *hexacanth embryo* is released.

This immediately commences to bore its way into, and even through, the coats of the stomach.

The majority of the embryos probably find their way into the small vessels of the part, and being swept along by the blood-current, they finally become more or less completely arrested in the intra-hepatic portal capillaries. Some probably penetrate the capillaries, and imbed themselves in the liver-substance; others, again, undergo their future changes without leaving the interior of the

blood-vessel. Experiments conducted upon sheep, lambs,* and goats by these observers were unsuccessful. However, the liver, and in many cases the lungs also, of the animals experimented upon were studded with white points, which resembled miliary tubercles, and which probably were the aborted and degenerated brood of the six-hooked embryos administered.

In pigs, however, the experiments were far more successful.

In the first instance, a sucking-pig was examined, four weeks after the feeding. There were found in it, small tubercular nodules, about one millimetre in diameter.

These were seen studded here and there, underneath the serous covering of the liver. Upon closer examination, they were found to contain in their interior smaller globular or vesicular bodies (0·25 to 0.35 Mm. in diameter), which were really juvenile Echinococcus cysts

They had precisely the appearance of a mammalian ovum. A thick, homogeneous and hyaline capsule enclosed moderately coarsely granular contents.

Each little body was enclosed in a mass which showed a cellular structure, and outside the whole, there was an envelope; this was of inconsiderable thickness, and everywhere was connected with the general connective tissue of the organ. It was clearly the adventitious capsule of the young bladder-worm.

Fig. 70.—Juvenile Echinococcus escaping from its capsule, four weeks after the experimental feeding. Multiplied 50 diameters. (After Leuckart.)

In another animal, examined a month later, and consequently eight weeks after feeding, the brood had attained about twice the size of those just described, and in this, as in the former case, the worms were found only in the inter-lobular spaces, and they showed an especial preference for the surfaces of the organ immediately underneath

* Krabbe on one occasion administered the ripe proglottides of Tænia Echinococcus, obtained experimentally from Echinococci of man, to a lamb, and found subsequently "here and there in the "liver and lung, small hydatids as large as a pin's head," but owing to the long interval between the feeding and the *post-mortem* examination (104 days), and the prevalence of hydatids in Icelandic sheep, this experiment cannot be regarded as by any means decisive.

the peritoneal coat. By this time, a partial liquefaction of the formerly solid contents had taken place, and thus a distinct vesicle was formed, yielding a clear fluid upon puncture.

The fluid had accumulated in the centre, so that within the cuticula or zona a second layer was distinguishable; this really was the *germinal membrane* of Huxley (*Keimhaut* of Naunyn). The cuticula had increased greatly in thickness, and showed plain indications of stratification.

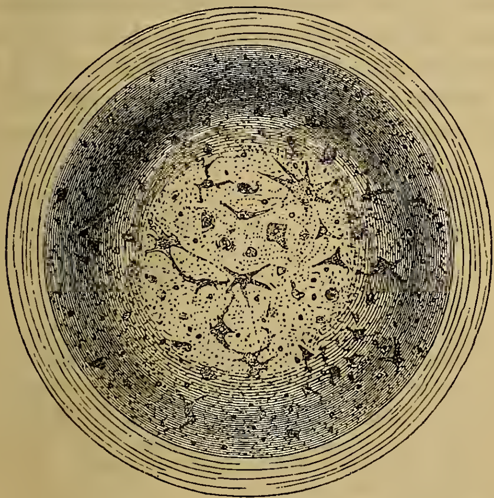


Fig. 71.—Echinococcus cyst, eight weeks' old. Multiplied 50 diameters. (After Leuckart.)

Neither by Leuckart nor Naunyn were the embryonal hooks of the boring embryo found, either at this or the earlier stage.

In a pig, examined nineteen weeks after feeding, Leuckart found, enclosed in the liver, from thirty to forty vesicular hydatids, which had now reached the size of a nut, but no Echinococcus-heads had yet developed in them. The cuticula measured about one centimetre in thickness, and had a stratified structure throughout.

The parenchymatous layer, although only thin, showed distinctly a division into two layers; in the external layer, calcareous corpuscles were observed, but as yet, no water vascular system.

According to Naunyn, the inner free surface of the internal layer of the parenchymatous stratum is provided with cilia.

II. **Stage of Simple Scolex-production.**—After passing a longer or shorter period (the term of which is at present unknown) in the acephalocystic stage just described, the little bladder-worm advances to the phase of scolex-formation. By this time it has reached the size of a hazel-nut, at least.

It has now a thick stratified cuticula, and the internal parenchymatous layer already described.

The formation of the scolices now differs widely from that of the corresponding structures in Cysticercus and Cœnurus, for instead of taking place directly from the mother vesicles, they arise secondarily, from brood-capsules.

The Brood-capsules.—These minute vesicles, owing to their delicate and fragile structure, were for a long time unknown, and were first discovered by von Siebold. By all the best authorities, the scolices are regarded as invariably taking their origin from them. As to the exact mode of development, both of the brood-capsules and scolices, considerable difference of opinion prevails, especially between Leuckart on the one hand, and Rasmussen and Naunyn on the other.

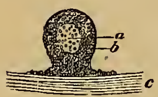


Fig. 72. — Incipient formation of a Brood-capsule in a secondary cyst. *a*. The knob-shaped bud. *b*. Commencing formation of the cavity in the same, by differentiation of the parenchyma. *c*. The striated wall of the parent cyst. (After Rasmussen.)

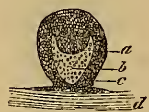


Fig. 73.—Later stage of development of the Brood-capsule. *a*. Scolex-knob. *b*. Cavity with internal cuticle and parenchyma. *c*. External parenchyma. *d*. Striated wall of mother cyst. (After Rasmussen.)

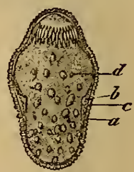


Fig. 74. — Brood-capsule containing a single Scolex. *a*. Its outer cellular layer. *b*. Its cuticle. *c*. Internal parenchyma. *d*. Scolex (Echinococcus-head) fully formed. (After Rasmussen.)

According to Naunyn and Rasmussen,* whose views agree in all cardinal points, the brood-capsules are formed from the parenchymatous layer (Endocyst of Huxley) as follows. At certain spots on the inner surface of this layer, an aggregation of small nuclear bodies takes place, so as to produce a minute knob-like projection. (Fig. 72.) In the interior of this, differentiation occurs, the nuclear bodies being converted into a finely-granular mass; as development proceeds, the cavity of the brood-capsule becomes gradually formed, its contour becomes sharper, and acquires the character of a cuticle, and bears on its inside a fine granular parenchymatous layer; through this layer vessels enter the brood-

* Bidrag til Kundskaben om Echinococcernes Udvikling hos Mennesket. Af Vald Rasmussen. Copenhagen, 1866.
An abstract of this paper is given in the "British and Foreign Medico-Chirurgical Review," for October, 1866.

capsule, spread over its internal surface, and send prolongations into each individual scolex. When the brood-capsule bursts, this internal parenchymatous layer partly holds the scolices together, so that the groups of scolices are found attached by their separate pedicles to a common granular mass, and it is in this condition that the Echinococcus-heads commonly present themselves under the microscope. The brood-capsule, from its fragile character, has usually disappeared so completely that its very existence was long unknown.

The earliest appearance of the scolex itself is a slight projection (Fig. 73), which takes origin in the end of the brood-capsule knob, just opposite to its place of attachment ; this increases in size until it fills up the interior of the rudimentary brood-capsule (Fig. 74). The latter structure itself has meanwhile continued to grow, and has acquired a pea-shaped form. The scolex-bud becomes strangulated at its point of origin, so as to form a peduncle.

Leuckart holds a different view, for although he does not deny that instances do occur in which the mode of origin of the scolex just described is seen, yet he asserts that this is an exceptional, and not the ordinary, mode of development.

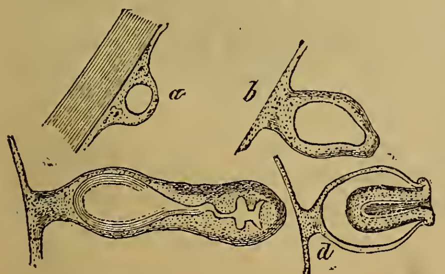


Fig. 75.—Development of the Brood-capsules and Scolices. (After Leuckart.) *a.* Early stage of the Brood-capsule. *b.* First indication of Scolex-bud. *c.* Further development of Scolex. *d.* Inversion of Scolex within the Brood-capsule.

Fig. 76.—Brood-capsule with one inverted Scolex and two externally attached Scolex-buds, in different stages of development. (After Leuckart.)

Instead of the Echinococcus-head arising from a *solid* cone projecting into the *interior* of the brood-capsule, he says, that its earliest form is that of a *hollow* cone, projecting from the *outside* of the brood-capsule, and consequently lying free in the fluid of the mother vesicle. He also gives a different description of the development of the brood-capsules. According to this author, the

process is somewhat as follows:—At a certain spot on the inner surface of the mother or primary bladder, there occurs a proliferation of the parenchymatous layer, so as to form a small wart-like prominence. (These little proliferous areas are, according to Naunyn, thickly beset with vibratile cilia.) Within this little prominence, a small spheroidal cavity forms. This then becomes surrounded by a delicate cuticular enveloping layer. We now have a little elevation possessing a central cavity lined with a delicate cuticula, whilst the outer crust consists of a cellular layer (*a* in Fig. 75).

This is the simplest form of the brood-capsule. At some point on this, usually opposite the peduncle of the brood-capsule itself, there forms a prominence (*b*, Fig. 75). This is the earliest phase of the scolex. It increases in size, projects further and further from the external surface of the brood-capsule into the fluid of the mother vesicle. The scolex-bud itself is hollow, and its cavity is indeed a continuation of that of the brood-capsule (*c* in Fig. 75). In the next place it may, and usually does, invert itself, so as to lie within the cavity of the brood-capsule (*d*, Fig. 75); it then has just the appearance observed and described by Rasmussen and Wagener, and believed by them to be the real and original mode of origin.

Fig. 77.—Brood-capsule of Echinococcus Veterinorum, with fully-formed (solid) heads, and also early (hollow) Scolex-buds. (After Leuckart.)

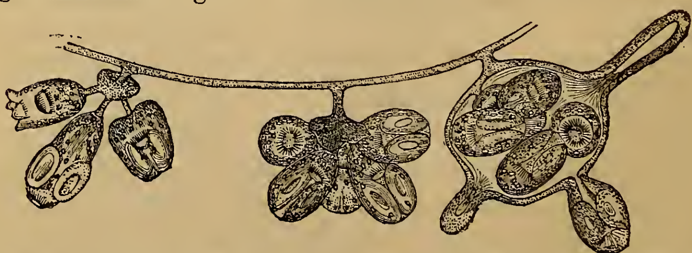


Fig. 78.—Three groups of Echinococci. In the left-hand and central figures, the brood-capsule has been destroyed, as is usual when Echinococci are found in the fluid removed by operation. In the right-hand figure, the brood-capsule remains uninjured. (After Leuckart.)

The points of difference between the views of these observers are, briefly, these: According to the one view, the scolices begin as solid buds, projecting into the cavity of the brood-capsule. According to the other, they take origin as hollow buds, projecting from the outside of the brood-capsule into the fluid of the mother vesicle.

Fig. 79.—Development of Echinococcus-heads from buds projecting into the interior of the brood-capsule.

(After Wagener.)

The whole of the parenchymatous layer, however, does not seem to be endowed with the power of generating brood-capsules, but this capacity exists only here and there, at variable distances, as is also seen in the case of Cœnurus. (See Fig. 31, page 31.)

Some hydatids never generate brood-capsules, and remain permanently sterile; these are the *Acephalocysts* of Laennec.

Usually, however, when the hydatid reaches the size of a hazelnut, they are formed, and often in vast numbers.

Each brood-capsule contains from one to twenty, or even more, scolices.

Sometimes dead and degenerated scolices are found enclosed, either alone or side by side, with living and active ones, in the same capsule.

III. **Stage of the Formation of Daughter Cysts.**—Leuckart considers that the brood-capsules, already described, may be regarded, morphologically, as repetitions of the mother hydatid, but on a smaller scale, and never existing independently of, and unattached to, the parent trunk. Echinococcus, however, is capable of showing a still higher degree of complexity than that already described, for it frequently produces a second progeny of cysts, resembling in structure and general appearance the mother cyst. These exist in a condition of absolute isolation from the latter, and are called daughter cysts. These, in turn, may produce a second generation like themselves, and this may continue to a third generation.

We thus have the so-called pillbox or nested hydatid, when the mother cyst encloses—floating free—in its interior more or less numerous daughter cysts, which in turn enclose granddaughter vesicles, within which, again, great granddaughter cysts may be

developed. The daughter cysts may be produced either endogenously or exogenously, in relation to the mother cyst.

Before proceeding to the consideration of the formation of daughter cysts, it is necessary to mention that, although the hydatid cyst has usually a globular form, yet that instances are met with in which this regularity of outline is not found, but the shape becomes irregular, sacculated or pouched; this arises in consequence of the irregular resistance encountered by the parasite during its growth. The hydatid always grows in the direction of least resistance, and hence it is usually found near the surface of the organs which it invades—at least during the advanced stages of its growth.*

The formation of daughter cysts in living Hydatids, even of large size, is not, as has already been stated, by any means universal. When it does occur, we have the form known as Echinococcus Altriciipariens (Küchenmeister), which is that most common in man.

Mode of Origin of Daughter Cysts.—As has been already stated, they may grow either outside the parent cyst (Exogenous variety) or within it (Endogenous cysts).

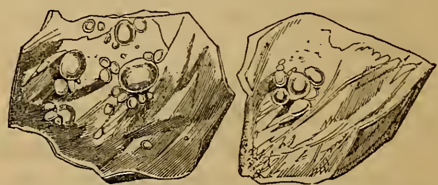


Fig. 80.—Proliferation of Echinococcus membrane—juvenile daughter cysts (natural size). (After Leuckart.)

When they grow *exogenously*, the process of their formation, according to Leuckart, is as follows:—Within the deep layers of the cuticula, at a certain spot, may be seen a small accumulation of granular substance, which separates the adjacent strata, and in time becomes itself enclosed in a cuticula of its own; this increases in thickness by the formation of additional layers, and a little vesicle is thus formed, which gradually approaches the external surface of the parent cyst. The small cysts thus formed may remain attached in little groups to the parent cyst for a certain time. They may then become detached, and thus be found enclosed within the adventitious sac of the mother Hydatid, lying between it and the parent cyst. Here they may either succumb to the pressure and die, or they may increase in size as independent parasites. They

* This is perhaps not the sole reason why hydatids are usually found near the surfaces of organs; for Leuckart observed in his experimental feedings (see page 92) that even the minute juvenile hydatids found at the fourth week were chiefly present just beneath the peritoneum, covering the surfaces of the liver.

then usually acquire a separate adventitious sac; in this condition they resemble Hydatids which have arisen directly from a separate boring embryo.

Although Leuckart describes the first elements of the daughter cysts as appearing between the layers of the cuticula, yet, in answer to an objection of Naunyn, he admits the probability that the real source of origin is the parenchymatous layer, and this quite accords with the views generally held by zoologists as to the relative vital activities of the cuticula and parenchymatous layer.*

A collection of such exogenously-formed secondary hydatids may be found grouped up into a lobulated mass, and enclosed in an adventitious sac, having loculi to correspond with each separate hydatid, as in Fig. 59, page 58.

Rasmussen gives a somewhat different description of the process of exogenous cell-formation. He describes the process thus:—

" In daughter cells, which have been developed in the mode described " from brood-capsules, and in which recognisable remains of scolices may " still be found, and especially in those which are comparatively large " and thin-walled, we see hernia-like eversions from the parenchymatous " layer, pushing the cuticle before them. The opening of the eversion " is sometimes rather striking; in other cases it is very fine and difficult " to recognise in profile. The eversion in which, therefore, both the " parenchyma of the mother cell and the cuticle take part, continues to " increase by independent growth, the cervix becomes more and more " constricted, and at length we have a little cyst, formed of a cuticular " layer with an internal parenchyma, and attached by a slender stalk to " the mother cell; finally, this separates completely, becomes free, and " is now developed, like any other Echinococcus cyst, in the acepha- " locystic stage. I have not observed any scolex-formation in such " daughter cells, nor in those which are developed from brood-capsules; " if every trace of scolices has disappeared in the brood-capsules, these " two forms, so different in their development, are no longer distinguish- " able from one another.

" These eversions may be repeated several times on a single little cyst, " and the cyst represented (Plate II., Fig. 1) exhibits this daughter cell- " formation in three different stages. It was found free within a se- " condary cyst, is consequently itself a tertiary cyst, and the cysts exo- " genously developed from it, of which one *(d)* is about to separate, are " therefore quaternary. It is evidently the same development which " has occurred in primary cysts to Kuhn, Davaine, Leuckart, and indeed " also to Naunyn, but which was by them interpreted in a different " manner. It is not difficult to understand how the types may have ap- " peared to Leuckart, which did not seem to him to admit of any other

* Thus Huxley, writing of the Endocyst, says, " It is the only active living part of the whole wall " of the cyst and represents the body-wall t." Op cit., p. 111.

" explanation than that the first germ of the daughter cell-formation
" took place between the cuticular layers of the mother cell, for, to con-
" tinue to use the simile already employed, this hernia-like eversion will,
" at a certain stage, come to lie in its hernial canal—the wall of the mother
" cell—whose thick cuticular layer, when the condition is not very favor-
" able, will easily be able to cover the fine canal (Plate II., Fig. 1 *f*).

" The condition is therefore incomparably more favorable for observa-
" tion in these thin daughter cells, so that in this case it is not easy to
" be deceived.

" The bulgings recently described and represented by Friedrich, in the
" so-called multilocular echinococcus tumour, seem to be only foldings
" of layer cells in narrower spaces (in this case the biliary ducts), such
" as often occur in the Echinococci of the ruminants, and not to be the
" commencement of exogenous cell-formations, as he assumes; they have,
" at all events, nothing in common with the development here described.
" But it is not common to meet with this exogenous formation of
" daughter cells, and it is certainly only a comparatively small pro-
" portion of the numerous cells contained in a larger cyst which are
" developed in this mode.

" The great bulk are formed endogenously from brood-capsules. But
" it appears from these investigations that, where the exogenous cell-
" formation occurs, it begins at an earlier stage, and precedes the
" development of scolices, and therefore also the endogenous formation
" of daughter cells."

Endogenous Formation of Daughter Cysts.—These arise, according to Naunyn, Rasmussen, and Leuckart, from the brood-capsules. Rasmussen thinks that they originate exclusively from these structures, and he considers that the scolices play in this development an absolutely passive rôle, but Naunyn, who is, in this respect, strongly supported by Leuckart, thinks that secondary cysts may also arise from Echinococcus-heads. The investigations of Rasmussen appear to have been conducted, chiefly, on the hydatids of man, those of Naunyn, principally, on these parasites in sheep, and this may possibly account for some differences of opinion between these writers. Leuckart describes the development of secondary cysts from Echinococcus-heads as follows:—

Amongst the innumerable little heads which are met with in the larger hydatid vesicles of the sheep, partly free in the hydatid fluid, partly enclosed in the brood-capsules, there are some seen to be altered in a peculiar manner. They are more transparent and larger than their companions, and contain, in the distended posterior part, a cavity filled with clear fluid, through which a distinctly fibrous cord, often enclosing vessels, extends towards the

head. On the internal surface of the body-wall, which will hereafter correspond with the peripheral envelope of the hydatid, there are to be seen ciliary lobes, and a network of fine fibres. The outer envelope is constituted by a structureless cuticula, which increases in thickness, and acquires the well-known stratified appearance, as the young hydatid increases in size and roundness. Gradually, the vesicle-formation invades the anterior end, the suckers disappear, as also do the calcareous corpuscles, the parenchyma spreads out, and, together with the already mentioned fibrous network, forms the parenchymatous layer of the newly-formed little hydatid. The circlet of hooks remains for some time as the last vestige of the Echinococcus-head, and when this, too, ultimately disappears, nothing remains to show the mode in which the secondary hydatid arose.

Fig. 81.—Metamorphosis into a daughter cyst of an Echinococcus-head enclosed in a brood-capsule. The brood-capsule contains several Scolices, some of which are in process of decay, the largest is being converted into a daughter cyst. (After Naunyn.)

When the metamorphosis of the Echinococcus-head has begun whilst it is yet enclosed in the brood-capsule, then the latter is ruptured, and its contents are liberated, before the conversion of the little head into a Hydatid has been completed.

The Metamorphosis of the Brood-capsules into Daughter Cysts.—It appears that those brood-capsules which contain partly decayed scolices are especially prone to undergo this process.

The first step seems to be a thickening of the hyaline envelope, and when this has advanced so far as to produce a firm stratified cuticle, the young cyst loosens itself from its place of origin on the mother cyst, the superjacent parenchymatous layer disappears, and, in the interior of the cyst, a new one forms, and this appears to be produced by the disintegration of the scolices formerly contained in the brood-capsule. The scolices attach themselves to the inside of the cuticle, gradually disintegrate, and, by spreading out over the inside of the cuticle, form an investment layer. For some time the hooklets remain and give a clue to the mode of origin

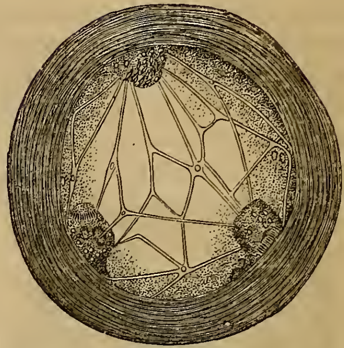


Fig. 82.—Metamorphosis of a brood-capsule into a daughter cyst. Attached to the inside of the thick stratified cuticle are seen three Scolices in process of disintegration, so as to form the new parenchymatous layer; multiplied 90 diameters. (After Naunyn.)

of these cysts, but in process of time even they disappear, and the little vesicle differs then, in no respect, from a Hydatid derived directly from a six-hooked embryo. Such are the steps of the process, as described by Naunyn, who is in all essential respects supported by Leuckart.

Rasmussen's account of the process is somewhat different. He apparently does not consider the parenchymatous layer as being the mere product of the disintegration of the scolices.

As has been mentioned, Rasmussen considered that the endogenous cell-formation proceeds exclusively from the brood-capsules, and he described the process thus* :—

" We meet, in cells of the size of a walnut or more, and also, though " exceptionally, in those of the size of a filbert, in addition to the ordi- " nary brood-capsules, with others, still adherent to the parenchyma of " the mother cell, or floating freely in its fluid, which are distinguished " by a striking granular parenchymatous layer on their inside. The " cuticle then soon begins to increase in thickness and to become lami- " nated, whereby the vesicle acquires more rigidity, and assumes a glo- " bular form, while it, at the same time, increases in size and the outer " parenchymatous cells disappear (Plate I., Fig. 4). The scolices may " still be preserved, but numerous fat granules are soon deposited in their " parenchyma and the suckers are destroyed.

" The scolices now gradually disappear, the anterior part with the " circlet of hooks remaining longest, then only this, with some parenchy- " matous *débris* and calcareous bodies remains, and, at last, only some " hooks and calcareous bodies are to be found scattered over the paren- " chyma: finally, these also disappear, and we have a little cyst, per- " fectly resembling the first acephalocystic stage of the Echinococcus " cell, developed by the metamorphosis of the Tænia embryo. This " grows now in the same manner as the former, by the deposition of " concentric cuticular layers internally from the parenchyma.

" I never succeeded in finding, with perfect certainty, vessels in such " cysts, at most I saw only fragments of such vessels (Plate II., Fig. " 1 *g*), notwithstanding that they were undoubtedly present here, as

* See review of Rasmussen's work in the "British and Foreign Medico-Chirurgical Review," No. lxxvi., October, 1866.

" well as in the brood-capsules, and it is precisely through these vessels " that resorption of the scolices takes place.

" Brood-capsules may also be met with in which only one part becomes " converted into a daughter cyst, the rest remaining unaltered.

" The process of sub-division and subsequent metamorphosis of brood- " capsules into daughter cysts may be frequently repeated in the same " cyst, as illustrated in Plate II., Figure 5.

" The whole was found swimming freely in a secondary cyst, about as " large as an egg. This preparation consists of a larger cyst *(a)*, with " laminated cuticle, and including many decaying scolices, consequently " it is a tertiary cyst, developed from a brood-capsule. In different " parts of this larger cyst, four smaller cysts *(b c, d, e)* are seen, with " thick laminated cuticles, whose outer layers intersect with that of the " larger cyst, with the exception of one *(d)*. All contain numerous, " partly unaltered, partly degenerating, scolices."

Once formed, the secondary hydatids are capable of producing a further generation of (tertiary) cysts, either by endogenous or exogenous formation, and, indeed, according to Rasmussen, the real mode of exogenous formation of cysts is far more easily discernible in the thin-walled secondary cysts than in the mother cyst itself, where the thickness of the wall obscures the details of the process.

" But it is not common to meet with this exogenous formation of " daughter cells, and it is certainly only a comparatively small propor- " tion of the numerous cells contained in a larger cyst which are de- " veloped in this mode: The great bulk are formed endogenously from " brood-capsules."

This applies, of course, to the variety of Hydatid most common in man. In the lower animals, the multiplication of cells takes place chiefly by exogenous development, as was long since carefully described by Kuhn.

Leuckart remarks, that if secondary hydatids arise exclusively from brood-capsules or scolices, then there could never be found sterile echinococci enclosing daughter cysts, and that *Echinococcus Hydatosus* must always be able to produce brood-capsules and scolices. But it appears as a matter of fact that Helm, in his investigations, has met with instances of Hydatids which contained daughter cysts in their interior, and yet which were apparently absolutely devoid of scolices. In order to explain this, one might suppose, either that such hydatids had exhausted their power of producing scolices, and that all the Echinococcus-heads originally produced had either become converted into secondary cysts, or had disappeared by degeneration, or else that the brood-capsules had proceeded directly to the formation of daughter cysts without

forming any scolices. Either or both of these processes are quite possible contingencies.

But still Naunyn suggests that daughter cysts may arise without the agency of either brood-capsules or scolices, in the following mode :—

The vesicle loses a portion of its watery contents and thus undergoes partial collapse. In consequence of this, at certain spots, the formerly opposed surfaces come in contact, and then, by becoming adherent, form little pouches, which enclose, of course, a corresponding portion of the parenchymatous layer.

The pouch becomes contracted at its base, and serves as the starting-point of a secondary cyst. This process exactly resembles that of the formation of exogenous daughter cysts, except that, in the one case, the pouching takes place within, and in the other outside, the maternal vesicle.

When this process is not complete, there will be seen, studded over the interior of the mother cyst, a series of cauliflower excrescences, each containing a central cavity; structures of this kind have been seen both by Eschricht and Leuckart.* The author, upon one occasion, met with *solid* excrescences more than $\frac{1}{4}$ inch in height, studded closely, over the area of a crown-piece, on the inner surface of an old mother cyst.

Upon the Fecundity or Sterility of Hydatid Cysts.—As has been already mentioned, some hydatids when examined are found to contain neither daughter cysts nor scolices. These are the so-called *Acephalocysts* of Laennec. It is, of course, a point of considerable interest to determine why such sterile cysts occur. It is possible that such cysts, when small, contain no scolices, because they are too young, for Leuckart noticed that, in the case of primary cysts, scolices did not occur until the cyst had reached about the size of a walnut.

Then, again, the hydatid may have reached too advanced an age to breed new scolices, and all those previously produced may have degenerated.

Besides these possible causes, there are others, which have been discussed by Helm† and other writers.

Helm points out that Leuckart's statement, that Echinococci of

*Op. cit., p. 789.

† Ueber die Productivität und Sterilität der Echinococcus-Blasen. Dr. Hermann Helm, in Archiv für Pathol Anatomie und Physiologie und für Klin Medicin, Berlin, 1880. p. 141, and seq.

the brain are always sterile, is a mistake, and he records three cases in evidence to the contrary. He is of opinion that many causes may occasion sterility in Echinococcus. Thus he suggests an inherited debility in the embryo; that the juvenile cyst may undergo dropsical degeneration; that the "soil" in which the little cyst is imbedded may be unfavorable, &c.

Probably, however, the most important causes are such as influence the supply of nourishment to the parasite. Thus degeneration or inflammation of the organ in which the cyst lies, by interfering with the supply of blood to the fibrous capsule, may not only prevent the development of scolices in it, but may even cause the death of the parasite. In support of his view, Helm mentions that the hydatids seen by Charcot and Davaine, attached by slender peduncles to the mesentery (see Fig. 83), were all sterile, whilst hydatids found in other parts of the body of the same person contained scolices.

Fig. 83.—Pedunculated hydatid cysts observed by Charcot and Davaine. *(a. a.)* Small intestine. *(b. b.)* Mesentery. *(c. c.)* Cysts with short pedicles. *(d.)* Another cyst attached by a very long and slender pedicle *(e)*. (After Davaine.)

Then, extreme induration, thickening, and calcareous degeneration of the fibrous capsule must seriously affect the vital energy, and may, indeed, arrest the very life of, the contained parasite, by interfering with the process of diosmosis, whereby it receives its food supply. Much further inquiry is needed upon this point; for example, as to the influence of "variation" in Echinococcus. For it is curious that the type found in man should be principally E. altriciparienss, whilst in the domestic animals there should, only exceptionally, be found daughter cysts. Probably a difference in the nature of the soil will explain the fact.

The Multilocular Hydatid Cyst. — *Synonyms.* — Alveolar colloid of liver.

Die Multiloculäre ulcerirende Echinococcus-Geschwulst. Alveolar Colloid der Leber. (Zeller.)

Tumeur Hydatique Alvéolaire (Carrière) Tumeur a Echinocoques Multiloculaire.

Under the designations mentioned above, a very curious form of Hydatid tumour has been known to pathologists for the last thirty years or so.

The earliest record of this disease was apparently made by Buhl, in 1852.* Two years subsequently, Zeller described a case where, upon microscopic investigation, Echinococci were found in the growth, but he regarded their presence as merely a curious epiphenomenon. In 1855, however, Virchow, in his usual masterly manner, established the true pathology of the disease, and beyond question demonstrated that these tumours have nothing to do with either cancer or alveolar colloid.†

Since then, other writers, *e.g.*, Carrière and Marie Prougeansky, have amply borne out the pathological views of Virchow.

That this form of Echinococcus is rare, is well exemplified by the facts that Carrière records only eighteen cases, and Marie Prougeansky only nineteen. The writer has not been able to find any record of such a case as having been observed in Australia, where Hydatid disease is so prevalent.

Before proceeding to the description of this remarkable pathological product, it is necessary to remember that it is by no means uncommon for Hydatid cysts to exhibit a sacculated form. Owing to some irregular obstruction, encountered by them in their growth, some portions project beyond the rest, and we then have a single cyst with more or less numerous loculi connected with the common cavity. Each pouch of the cyst acquires its special adventitious sac, and thus we have the appearance of a growth consisting of several nearly distinct pouches. These appearances were described and figured by Kuhn.‡

---

*Illust Münchener Zeitung, Vol. I. 1852.

†Verhandlungen der Physikalish, Med., Gesellschaft in Würzburg, 1855.

‡Recherches sur les Acephalocystes, par le Doctour Kuhn. Strassburg, 1832.

According to him, such groups of Hydatids are frequently met with in the liver of the ox.

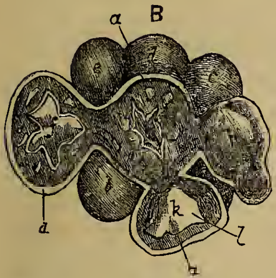


Fig. 84.—Loculated Hydatids, showing the principal cyst and several pouches connected with the chief fibrous capsule.

The different loculi in which the cyst lies communicate with one another, so that there really is one adventitious sac, divided into several different compartments.

In the specimen (Fig. 84) the entire growth was undergoing the so-called atheromatous degeneration. This form of Hydatid has also been figured by Leuckart, under the title of Echinococcus racemosus.


Fig. 85.—Echinococcus racemosus. (After Leuckart.)

Pathological Anatomy.—The chief characteristics of this variety of Hydatid are:—

1st. Its multilocular structure.

2nd. Its tendency to undergo, at various spots in its interior, a process of what may be regarded as ulceration.

3rd. Its tendency to end fatally.

According to Ott, this form of cyst has been observed in the Liver, and in certain bones (*i.e.*, the Tibia, the Cranial bones, and those of the Pelvis); but there is no satisfactory evidence that it really has ever been found connected with the osseous system, and it seems that the cases of this kind referred to by Ott were merely instances of Hydatids, partly collapsed, and contained in loculi of the bones in question.

In the eighteen cases collected by Carrière, the seat of the disease was seventeen times in the liver, three times in the lungs, and once in the peritoneum.

In respect of the organs most commonly attacked, the disease resembles the common form of hydatids, as might have been expected. So also, with regard to locality in the organ affected, the larger right lobe of the liver being far more frequently invaded than the smaller left one.*

Imbedded in the liver we find a solid tumour, varying in size in the cases recorded from that of a duck's egg to twice the size of a

* In point of weight, the right lobe is to the left about as six to one.

man's head. Between these extremes there may be found all intermediate magnitudes.

The tumour is heavy, tough, and of cartilaginous or even bony hardness, but it is not uniformly so in all parts, and it may exhibit local, or even general, fluctuation. Usually more or less rounded in shape, it may be pyramidal or irregular at times. There may be only one, or many, foci of disease, and, in the latter case, the separate foci may either be completely isolated, or they may be connected by communicating bands of degenerated tissue. When there are several growths present, projecting above the general liver surface, they may bear a deceptive resemblance to scirrhous nodules.

Upon section the surface shows numerous small cavities of irregular shape, which are separated from one another by connective tissue bands of varied thickness.*

In the loculi there is found a moderately transparent gelatinous pulp. Here and there a blood-vessel or a degenerated bile-duct courses through the mass, but within the limits of the tumour proper the liver substance has totally disappeared, and the gland structure is usually tolerably sharply defined at the periphery of the growth. Towards the circumferential part of the section the alveoli are usually small, and the connective tissue element predominates, and in the very outer portions there are sparsely-scattered solitary liver cells and acini. The liver cells, however, are degenerated, their nuclei are indistinct, their contents showing fat granules and biliary coloring matter.

Fig. 86.—Section through a mass of Echinococcus Multilocularis, natural size. (After Leuckart.)

In the central older part are found irregular cavities, varying in size from

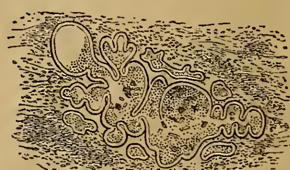


Fig. 87.—Echinococcus Multilocularis, magnified 30 dia. (After Leuckart.)

* These connective tissue bands are believed by Carrière to be due to the degeneration of the prolongations of the capsule of Glisson.

that of a pea to that of a man's fist. These are plainly the results of an ulcerative process. In some cases, the larger cavities do not show the same preponderance towards the central parts of the growth, but large and small excavations are scattered indiffe-rently over the entire surface of the section.

Occupying these cavities is a dirty, thickish, pulp, consisting of gelatinous particles, hyaline membranes and skins, crystals of hæmatoidin, bilirubin, margarin, and cholestearin, as well as biliary deposit and detritus.

The walls of the cavities are eroded, and perforated by orifices leading into adjacent loculi. On the surface, there are seen shreds of the degenerated tissue, projecting into the cavity.

The amount of damage done to the normal tubular structures of the organ varies. Sometimes the canals are merely narrowed: At other times the biliary ducts, blood-vessels, and lymphatics of the part have become more or less completely obliterated and des-troyed.

The lymphatic vessels have been seen distended, in places, into knots. Even the vena cava inferior, outside the liver, may be compressed, or invaded by the growth.

The Microscopic Structure of Multilocular Ulcerating Hydatid.— The general naked-eye character of alveolar structure is found also to prevail, on a small scale, in microscopic sections.

The stroma consists of the ordinary connective tissue fibres mixed with elastic fibres.

There are also abundant rounded, fusiform or irregularly-shaped cells, often anastomosing freely with one another. Here and there are seen pigmentary deposits derived from the bile. In the neighborhood of the cavities fat granules and crystals of hæmatoidin occur.

Here and there, but especially towards the periphery of the growth, there may be found hepatic cells in a condition of more or less advanced degeneration.

Within the loculi of this connective tissue is found a gelatinous substance consisting of membranes, which are sometimes folded upon themselves several times, or which may form a single mem-branous layer, lining the interior of a loculus. These membranes present the usual stratified structure of hydatid cysts. They are hyaline, transparent, and, usually, nearly or quite colorless.

As regards the causes that lead to this peculiar form of Echinococcus very little is known. Virchow was of opinion that it was due to the development of the parasite in the lymphatic canals of the part. Schröder van der Kolk, Friedreich, and Morin thought the primary seat to be in the biliary-canals, and Leuckart is inclined to localise it in the blood-vessels.

We are now in a position to summarise as follows, viz:—

That there is but one species of Echinococcus, which, however, may be found in four varieties.

1st. As an Acephalocyst. Here we have the Ectocyst or Cuticula lined with an Endocyst, which, however, has either not yet reached the stage of maturity to form brood-capsules or secondary cysts; or, having reached the age, it has not acquired, or has lost, this power.

2nd. The variety known as E. Scolicipariens or E. Simplex. Here there are brood-capsules formed, which in turn give rise to scolices. Inasmuch as the two next-mentioned forms also give rise to scolices, the title Echin. Scolicipariens is a less distinctive one than Echin. Granulosus.

3rd. Echin. Altricipariens or Veterinorum, where daughter cysts are developed. Of this, there are two sub-varieties, the Exogenous and the Endogenous; but between E. Altriciparieus and E. Soliciparions, no specific distinction exists. Both may be found in the same host together.

4th. The Multilocular variety.

The Spontaneous Death and Decay of Hydatid Cysts.—Echinococcus, like every other animal, is born, grows, and ultimately, as regards the individual form, dies. If the host of a living scolex-containing Hydatid becomes the prey of a dog or wolf, the cystic worm itself ceases to exist, but the living scolices form the starting-points of a new generation.

But the Hydatid cyst may, whilst still within the body of its living host, burst, and the place and mode of this spontaneous rupture will have the most important consequences, both for the host and the parasite itself.

Thus, if the rupture occur into any of the passages communicating with the exterior, *e.g.*, the intestinal or bronchial tract, then the Hydatid will be discharged into the outer world, perhaps with a vast number of still living scolices attached to it. These may

then be swallowed by dogs, as is probably often the case in Iceland, and thus a new brood of Tæniæ be produced.

But, on the other hand, if the Hydatid ruptures into an enclosed space, such as the pleural or peritoneal cavity, the destruction of the parasite, and the death of the host, will usually result.

But there is yet (apart from surgical interference) another mode of death to which the hydatid is liable, for it may die whilst still enclosed in the living body of its host.

In this case its death occurs in its berth, and its cradle forms its shroud. It is, of course, impossible to estimate in what proportion of cases Hydatids reach this end; but it is, although not very rare in man, certainly far less common than the occurrence of rupture. It is chiefly in small cysts that this is most likely to take place, and there is reason to think that it occurs more frequently in oxen and sheep than in man.

Cases are, however, not rarely encountered in the *post-mortem* room, where, either in the liver or some other organ, there are seen one or more Hydatid cysts, which, instead of containing the usual watery or thick fluid, have, instead, solid contents much resembling ordinary putty in appearance. Under the microscope, this putty-like substance is found to consist of fat and granular *débris*, carbonate and phosphate of lime, cholestearine, hooklets, and *débris* of Hydatid membranes and scolices.

Cysts containing such matters have been frequently observed and described as *Atheromatous cysts of the Liver;* and instances of "suppurated Hydatids," "Hydatids converted into abscesses," or into "tubercles," are by no means rare in the records of medicine.

It is probable that, in nearly all these cases, what really had taken place was a more or less advanced degree of this so-called atheromatous degeneration, the earlier stages being represented by thick fluid contents, bearing to the naked eye a most deceptive resemblance to pus, but under the microscope consisting of innumerable granules, insoluble in ether, and mixed with granular masses of somewhat indefinite outline. A further degree of this change results in the production of a matter resembling crude tubercle so closely that Jenner thought that he had found the origin of tubercle in Hydatids.

The most advanced degrees are represented in those cases where the contents of the sacs have acquired the consistence of putty or

thick plaster, and, finally, when there remains nothing but an encapsuled cretaceous nodule.

That the causes of these degenerative changes must be looked for in the local conditions of the parasite itself, and not in the state of health of the host, is amply shown by an observation recorded by Cruveilhier, where a hydatid of the spleen contained a matter resembling plaster, whilst a cyst of the liver had contents like pus, and Bremser observed in the ox healthy hydatid cysts side by side with others undergoing all degrees of degeneration.

It is clear, therefore, that it is to local and not to constitutional causes that these degenerations are referable.

As has been already stated, atheromatous changes are found chiefly in cysts of small or moderate size, and Dr. Kelly* remarks that—

"As a rule these cysts are not diagnosed during life, as they do "not in general exceed the size of an orange, are often on the under "surface of the liver, and seldom produce any symptoms by which they "may be recognised."

However, instances are not wanting of very large cysts found in a condition of more or less advanced atheromatous degeneration.

The general characters of these degenerated Hydatids were well described by Kuhn, in 1832.†

If a section be made of a solid atheromatous nodule, it will be seen to show, externally, the original capsule often much thickened and degenerated; inside this there is cheesy or "tubercular" matter, often yellowish in color, which encloses the folded remains *(c)* of the true parasite, which are often studded with calcareous concretions *(e)*.

Fig. 88.—"Atheromatous" Hydatid cyst from the spleen of an ox. *a*, Section of the capsule; *b*, "Tubercular" matter; *c*, Remains of folded cyst; *d*, Bud-like process of cyst; *e*, Calcareous concretions. (After Kuhn.)

The collapsed hydatid, when removed from its adventitious capsule and floated out in water, is often found to be very much larger than its fibrous sac, and hence the folded-up appearance presented by the parasite whilst contained in its original situation.

Sometimes a degenerated cyst is found completely filled with collapsed daughter

* On the spontaneous cure of Hydatid cysts: by Charles Kelly, M.D. "The British and Foreign "Medico-Chirurgical Review." Vol. lxxxviii. Octr., 1869., p. 494 *et seq.*
† Recherches sur les Acéphalocystes et sur la manière dont ces productions parasites peuvent donner lieu a des Tubercles.

cysts, which may be then as closely packed as the dried raisins of commerce.*

Cases of this kind have been recorded by Budd,† Murchison,‡ Bright,‖ and others.

In all these cases of spontaneous cure of hydatids, the fibrous sac has always been found thickened and degenerated to a greater or lesser degree. It may be dense and fibrous, or studded in places with patches of cartilaginous toughness, or invaded by calcareous degeneration.

In some instances, the entire wall has been found completely "ossified," as in the case of a cyst the size of an orange, recorded by Bright §; usually, however, calcification occurs only in patches.

The fibrous sac, being derived from the connective tissue of the organ which harbors the hydatid, may share in the diseases of the organ, *e.g.*, carcinoma or lardaceous degeneration. Instances of liver cysts affected by both the last-named diseases have been recorded by the author.¶ Dr. Whittell, of Adelaide,** first drew attention to the fact that minute bodies resembling Psorospermia were to be found in the contents of hydatid cysts undergoing spontaneous degeneration. He concludes from his observations:—

1st. That Psorospermiæ are frequently to be met with in hydatid cysts, their existence there affording an example of a parasite within a parasite.

2nd. That these bodies are not found in the early life of the hydatid.

3rd. That when they are found, they afford evidence that degenerative changes have already commenced in the cyst.

Dr. Whittell describes these objects as—

"Flattened bodies, the greater number of which are ovoid in "shape. The largest I have measured was $\frac{1}{570}$ inch long, and $\frac{1}{1140}$ inch "wide. Some of the smaller specimens measured $\frac{1}{1600}$ inch long and "$\frac{1}{3000}$ inch wide. Some are considerably elongated, while others look

---

* Budd. Diseases of the Liver.

† Budd. Diseases of the Liver.

‡ Transactions of the Pathological Society. Vol. xviii., p. 125.

‖ Guy's Hospital Reports. Vol. ii. Series I., p. 450.

§ Guy's Hospital Reports. Vol. ii., Series I., p. 462.

¶ Hydatid of liver, followed by carcinoma. Case 2. Hydatids of liver, simulating cyst of spleen. Lardaceous degeneration of liver, spleen, stomach, kidneys, and intestines. Case 3. *The Medical Times and Gazette*, November 6th, 1880.

** "On the association of bodies resembling Psorospermia, with degeneration of hydatid cysts," by H. T. Whittell, M.D., F.R.M.S. Journal of the Quekett Microscopical Club. No. 43, vol. vi., p. 47.

" like mere specks under a $\frac{1}{5}$ objective, but when carefully examined
" under a $\frac{1}{25}$ inch immersion lens, they show the same appearance as the
" larger specimens. Dilute acetic acid does not appear to affect them,
" nor do they polarise light. I have been unable, with the highest
" powers in my possession, to make out any internal structure."

The writer has met with bodies resembling those described by Dr. Whittell in some cases of atheromatous cysts.

It is interesting to note that cholestearine plates may be sometimes found in hydatid cysts, whilst the contained fluid shows no other sign of degeneration than a faint opalescence; even in such cases, however, the scolices present show plain indications of degeneration.

In the cases collected by Kelly the locality of the degenerated cysts was as follows:—

Situation.	No. of Cases.
Liver	32
Omentum........................	3
Spleen	1
Between Bladder and Rectum	2
" Stomach and Colon........	1
In Vertebral Canal................	1
Total................	40

Considerable difference of opinion prevails as to the causes that lead up to the death of the parasite, but the conceivable causes may be classified into two groups—

1st. Those acting directly upon the parasite.

2nd. Those acting upon the parasite by the intervention of the Fibrous capsule.

Of the first group of possible causes, one of the most important is probably the excessive multiplication of daughter cysts. Sir Thomas Watson holds this as a probable cause of its death. He writes:—

" Sometimes the whole colony perishes while yet hid in its dwelling-
" cave, all the enclosed Hydatids losing their vitality and shrinking up
" as their fluids are absorbed. It may be that they increase in number
" and in size till the crowding and pressure prove fatal to them. Their
" former domicile now becomes their tomb, and effectually precludes any
" contamination of the fluids of the body, or irritation of surrounding
" textures, by their remains."*

That this is a potent cause in some instances can hardly be doubted.

A second probable cause is that the Echinococcus cyst, like all

* Lectures on the Principles and Practice of Physic, vol. ii., p. 561.

other living organisms, has a certain term of existence, after having reached which its vitality is exhausted and it dies.

However, in some instances, at least, it is evident that under favorable circumstances its natural term of life is a very long one.

It seems certain that by far the most common cause of death of the Hydatid must be sought for in the condition of the fibrous capsule, and the steps of the process may be regarded as tolerably well explained by the observations of Cruveilhier,* Kuhn,† Kelly,‡ Leuckart, and others.

As soon as the hexacanth embryo has ceased its active wandering and has settled itself for life in the liver, for example, a process of encapsuling occurs, at the expense of the organ invaded. In the case of the liver, the little parasite always, according to Leuckart, starts its sedentary life in an interlobular space. Here a proliferation of the connective tissue occurs, which results, in the first place, in the production of a cellular envelope. With advancing time this acquires increased consistency and thickness, until, at last, we have a more or less thick and firm fibrous capsule, the inner surface of which is smooth and lined with a kind of epithelial layer. The fibrous capsule thus formed is usually well supplied with blood-vessels, which can often be seen to commence in the healthy tissue of the organ adjacent to the parasite, and to ramify out into the fibrous sac.

It is only through the vascular supply of this adventitious sac that the imprisoned Hydatid can receive, from the blood of its host, the pabulum necessary for its life, and without a sufficient supply of nutriment the hydatid, like any other living animal, must die.

The fibrous sac, like all similar growths, tends with advancing age to contract and become more dense, and in doing so it will diminish the calibre of its vessels, and this, by interfering with the circulation in its substance, leads up to calcareous degeneration.

In some cases, it is alleged that true ossification occurs in portions of the capsule.

That these degenerative changes are due to local impairment of the vascular supply is shown by the circumstance that, almost invariably, extreme induration and calcification occur only in patches of the capsule, other parts remaining unaltered.

---

* Anatomic Pathol Generale, Tome iii. † Recherches sur les Acéphalocystes. ‡ On the spontaneous cure of Hydatid cysts. "British and Foreign Medico-Chirurgical Review," Oct., 1869.

As the capsule becomes tougher and less vascular, the formerly smooth, glistening internal surface undergoes very striking alterations. According to Kuhn,* there is first seen on the inner surface of the capsule, *i.e.*, between it and the outer surface of the Hydatid, a thin layer of yellowish, soft, and semi-transparent matter. This afterwards becomes thicker and more opaque, and concretes in such a way as to form small lines or undulating striations. Sometimes these lines are joined by connecting undulating ones; at other times they radiate sinuously from a central nucleus.

Gradually this deposit increases in thickness, and pushes before it the wall of the hydatid, which thus becomes cut off from its source of nourishment and dies. In the course of this process the hydatid wall becomes variously folded upon itself. Ultimately, all that may be left of the former parasite is a dense sac, enclosing a matter resembling, to the naked eye, crude tubercle, and enclosing shreds of striated membrane and hooklets. This matter is undoubtedly a product of the fibrous capsule, and not of the hydatid, and Kuhn especially insists "that one has "never found tubercular matter in the cavity of an acephalocyst." This matter is found constantly between the cyst† and the parasite. But this assertion is by no means borne out in the case of the degenerated hydatids of man, for it is common to meet with the contents of the hydatid itself, in a condition resembling thin plaster of Paris, or even as solid as glaziers' putty.

The yellowish atheromatous matter is rich in lime salts, which in advanced cases may accumulate so as to form solid concretions of conspicuous size; these are usually irregular in shape, but they may at times exhibit a distinctly crystalline structure.

They may be found from the size of a millet-seed to that of a hempseed, or even a pea, but the larger concretions show no crystalline structure. According to Kuhn, these concretions are ordinarily scattered through the whole of the tubercular mass; but when a tubercle is only in course of formation, they are found chiefly at the spots where the tubercular matter is mostly collected. Sometimes these calcareous concretions are white, soft, and easily reduced to powder; they are then formed solely of carbonate of lime.

---

* Op. cit., p. 10 and seq.

† Kuhn, like Davaine and many others, confines the expression "kyste" to what, in this work, i described as the fibrous or adventitious sac or capsule. (See page 55.)

Others are yellowish, tough, osseous, and contain a considerable proportion of phosphate of lime. Both varieties of concretions are frequently met with in one and the same tubercle.

In the case of a multiple brood of daughter cysts, produced exogenously from a parent cyst (a condition common in the liver of the ox), each daughter cyst is usually found imbedded in a separate accumulation of tubercular matter, the whole being enclosed either in a separate sac or in a loculus of a large common capsule, as in Fig. 84, page 107.

Kuhn considered that the death of the parasite was the result of the impairment of nutrition, induced by the accumulation of this tubercular matter between the fibrous sac and the parasite. Kelly holds a view somewhat different from this, and which may best be explained in his own words.*

"In the early development of the hydatid the outer wall is in some "cases thicker and more unyielding than in others; as the endocyst† "grows it fails to dilate the outer coat to any great extent, and the "consequence of this relative disproportion of growth is that the endo-"cyst becomes doubled and involuted on itself, and the sac is not filled "with fluid, but with folds of lining membrane and secondary cysts; "vital changes for a while go on, and the hydatid grows; but a time "soon comes when these changes cease, as the pabulum secreted is in-"sufficient to support the life of the closely-packed contents. Chemical "and physical changes then take place, the hydatid dies, the lining "membrane suffers fatty degeneration, the Echinococci become disin-"tegrated, and cholestearine and lime salts are deposited. These cysts, "then, do not contain fluid which is afterwards absorbed, but their death "is caused by relative disproportion of growth between the sac and the "endocyst at the very commencement of their development, and the "crowding together of membrane and secondary cysts without sufficient "fluid being secreted to support their existence.

"This, in a great measure, must depend upon accidental circumstances— "as the position of the cyst, where it may be unable to expand readily; "the slowness of growth of the endocyst, by which the outer sac has time "to become thicker and more resistant; or the presence of atheromatous "changes in the fibrous sac, in which case the nourishment of the con-"tents must be more or less interfered with.

"If, on the other hand, the fibrous sac be thin and yielding, it will "give way before the development of the endocyst, which, instead of "being folded upon itself, will merely line it, and, as it grows, the "pabulum, which, as before mentioned, is constantly moistening the "outer side of the hydatid membrane, will pass in, and fluid be secreted "to fill up the space formed by the expansion of the cyst. These are

* Loco citat, p. 496.

† Kelly employs the word endocyst to describe the entire parasite itself.

"the cases which attain sometimes a large size, and may require opera-"tive interference; they may be diagnosed during life."

In favor of his views Kelly advances the facts that none of these cases exhibit signs of cicatricial contraction of the fibrous sac, *e.g.*, puckering and shrinking, even in instances where the hydatid itself, when floated out in water, is found to have a superficies three or four times as great as the enveloping capsule.

Again, he remarks that "no cases of spontaneous cure have been "found in the lung or brain, or anywhere where enough resistance "cannot be offered."

This, however, is not quite correct, for Kuhn* describes and figures several instances of "atheromatous," or "tubercular" cysts from the lungs of oxen, and, even in man, such cases have been observed; thus Dr. Allen, of Melbourne,† has recorded two cases of the kind, and others are not wanting in the records of medicine.

Again, in the case of lung hydatids, rupture into a bronchial tube is so common a termination that from this circumstance alone no particular inference of the kind drawn by Kelly can hold good.

Besides, the comparative rarity and the great danger of echinococcus in the brain would render it unlikely that degenerated hydatids should be recorded as occurring in this locality.

Kelly sums up the conditions favorable to the spontaneous cure of Hydatids thus:—

1st. A thick, unyielding outer fibrous sac.

2nd. Relative disproportion of growth between the "endocyst" [*i.e.*, the parasite] and the sac in which it lies.

3rd. Calcareous or atheromatous changes in the fibrous tissue which forms the sac.

4th. Situation in a confined part, so as to prevent rapid growth.

It does not seem likely that the mere situation of the hydatid has much influence in causing spontaneous death, otherwise hydatids occupying the interior of bones could hardly escape this fate. The author has had under his care a case of hydatids occupying a cavity excavated in the substance of the right iliac bone, where no trace of degeneration had occurred in the cysts evacuated by operation. Moreover, Kelly himself records, in his table of cases, three instances of omental cysts, as well as one where the cyst lay between

*Op. cit., Figs. 5, 6, and 9.

†Notes of cases of Hydatid disease, from the pathological records of the Melbourne Hospital (cases 11 and 18), from the *Australian Medical Journal*, 1881, pages 193 and 200, by Prof. H. B. Allen.

the stomach and the colon, all of which had undergone spontaneous cure.

Now, it is scarcely possible to conceive any locality in which a Hydatid could meet with less resistance than in the last-named places.

It is probable, then, that the spontaneous death of the Echinococcus cyst may arise either because the animal had reached its natural term of existence, or in consequence of an excessive production of daughter cysts, or as a result of the degeneration of the Fibrous capsule, whereby its supply of nourishment has been reduced to the starvation-point.

Of these probable causes, undoubtedly the most generally important is the condition of the Fibrous capsule.

Upon the Distribution of Hydatids in the Human Body.—Echinococcus enjoys a wider distribution of seat in the interior of its host than does any other parasite.

No blood-containing organ or tissue is sacred from its invasion. The liver, the lung, the brain, the heart, nay, even the very marrow of the bones, are liable to harbor this pest.

But the various parts of the body are by no means equally frequently infested, as will be seen by reference to the subjoined table, copied from Neisser.*

Table showing the Number of Cases in which the various Organs and Tissues were invaded by Echinococcus, principally or entirely European cases.

Organ or Tissue.	Davaine.	Böcker.	Neisser.	Finsen.
Liver	166	27	451	69 °/o 176
Lung	40	5	67	3 "
Spleen	—	4	28	—
Pleura	—	—	17	—
Organs of circulation	12	1	29	—
Cranial cavity	22	—	68	—
Spinal canal	3	—	13	—
Kidney	31	2	80	3
True pelvis	26	1	36	54
Female organs of generation and mamma	13	—	44	— —
Male organs of generation	3	—	6	—
Bones	17	—	28	—
Face, orbit, mouth	16	—	21	—
Neck	7	—	10	—
Trunk and limbs	20	—	—	—
Omentum	—	—	2	—

* Die Echinococcen-Krankheit, von Dr. Albert Neisser. Berlin, 1877, p. 25-26.

Dr. Osler supplies the following record, showing the organs attacked in the cases of Hydatids collected by him from various sources in America.*

Table of Cases of Hydatids observed in America.

Organ Affected.	Number of Cases.	Organ Affected.	Number of Cases.
Liver	44	Pelvis	4
Spleen	4	Brain	2
Lung	5	Stomach	1
Abdominal wall	2	Sub-cutaneous	1
Bladder	1	In common bile-duct	1
Bones	1	Discharged from intestines	5
Peritoneum, Omentum, and Mesentery	7	Vomited	2
		Expectorated	2

From the statistics of Hydatids procured from the principal hospitals of the Australasian colonies, and tabulated by the author, the subjoined table has been prepared, showing the proportion in which the various parts of the body were invaded.

Table exhibiting the proportion in which the various Organs and Tissues of the Body are attacked by Hydatid Disease, as shown by the Statistics of Australasian Hospitals.

CLASS A.—SINGLE CYST.

Locality of Cyst.	Victoria.	New South Wales.	South Australia.	Queensland.	New Zealand.	Tasmania.	Totals.
A. *Organs of Abdominal Cavity—*							
Liver	306	60	134	3	21	8	532
Omentum	12	1	5	—	1	—	19
Peritoneum	—	—	1	—	—	—	1
Spleen	3	2	—	—	1	—	6
Kidney	2	1	2	—	3	—	8
Uterus	4	—	—	1	4	—	9
Ovary	3	4	—	1	1	—	9
Prostate gland	—	1	—	—	—	—	1
"Elsewhere in the abdomen"	24	4	5	—	1	—	34
B. *Organs of Cavity of Thorax—*							
Lung	83	8	42	—	1	—	134
Pleura	—	1	1	—	—	—	2
Heart	2	2	—	—	—	—	4
"Thorax"	—	—	1	—	—	—	1

On Echinococcus Disease in America," by William Osler, M.D., M.R.C.P. (Lond.), in the "American Journal of the Medical Sciences." October, 1882.

CLASS A.—SINGLE CYST—*continued.*

Locality of Cyst.	Victoria.	New South Wales.	South Australia.	Queensland.	New Zealand.	Tasmania.	Totals.
C. *Nervous System*—							
Brain	5	2	1	—	1	—	9
Spinal cord	—	1	—	—	1	—	2
D. *Locomotive Organs*—							
Muscles	4	*4	5	—	—	—	13
Bones	—	2	—	—	—	—	2
E. *Sub-cutaneous Cellular Tissue*—	6	†1	‡9	—	4	—	20
Female breast	2	—	1	—	—	—	3
Situation not mentioned........	516	1	23	—	—	1	541
	972	95	230	5	39	9	1,350

CLASS B.—MULTIPLE CYSTS.

Locality of Cysts.	Victoria.	New South Wales.	South Australia.	Queensland.	New Zealand.	Tasmania.	Total.
In the liver only	6	7	—	—	6	3	22
In liver and lung...............	9	2	—	—	5	—	16
Liver, lung, and omentum......	1	—	—	—	—	—	1
Liver and kidney...............	3	—	—	—	—	—	3
Liver, spleen, kidney, bladder, and mesentery	1	—	—	—	—	—	1
Liver, and "elsewhere in abdomen"	4	4	1	2	7	—	18
Liver, omentum, and testis	1	—	—	—	—	—	1
"Abdominal cavity"	—	1	—	—	—	—	1
In the lungs only	2	—	—	—	—	—	2
Lung, heart, and spleen	1	—	—	—	—	—	1
Lungs and pericardium	1	—	—	—	—	—	1
	29	14	1	2	18	3	67

If we examine the figures recorded by Neisser (which include

* Including the diaphragm once, and one "sub-scapular" cyst. † Over the deltoid muscle.

‡ Including one in the forehead. Three in the neck and one in the cheek. Some of these may have been deep-seated.

the tables of Davaine and Böcker), we find that, out of a total of 900* cases, 451 occurred in the liver, and sixty-seven in the lungs; but if we similarly examine the tables of the Australasian hospital cases, we find that, out of 800 instances in which the situations of the hydatids were recorded, in the class of single cysts, the liver was the seat in 532 instances, and the lungs in 134 cases. From this it appears that Echinococcus occurs with especial frequency in the liver, but that in Australasia a disproportionately large number of lung hydatids had been observed; this will be rendered more clear perhaps if the percentage proportion be noticed, as in the table adjacent.

Organ.	Proportion per cent. of Total Cases.		Ratio of Lung to Liver Cases. (In round numbers.)
	Neisser's Table. (Europe.)	Author's Tables. (Australasia.)	
Liver	50·11	65·76	In Europe, 1 to 6½
Lung	7·44	16·56	In Australasia, 1 to 4

It has been noticed by Dr. Dougan Bird,† of Melbourne, that there is a "remarkable frequency of lung hydatids here (*i.e.*, in "Victoria) relative to those in the liver or elsewhere," and the figures just cited bear out the general correctness of Dr. Bird's opinion. The explanation offered by Bird is that—

"The dust of our streets (in Melbourne) is the result of mud from the "frequent use of the Yan Yean hydrant, dried by the hot wind, and "powdered by the constant traffic of the day. It is notorious that this "fine dust does, during respiration, enter the air passages, more par- "ticularly of women, who are less protected about the mouth and nose, "by hair, than men. Nothing is more likely than that the dried-up "ovum, revivified by the moisture and steady warmth of the body, should "now commence its new career. Any one who has witnessed the draft- "ing of sheep or cattle on a hot day will readily understand how well "this dust theory applies also for the explanation of the origination of "pulmonary hydatid in those engaged in pastoral pursuits, the readily- "dried and pulverised droppings of the sheepdogs furnishing the "*materies morbi* ready made on the spot."

* Neisser makes his total amount to 983, but the correct sum total of his figures amounts only to 900. Op. cit., page 26. He gives no explanation of his anomalous total.

† "On Hydatids of the Lung," S. Dougan Bird, M.D. Melbourne, 1877. Second edition, pp. 2 and 3.

It is evident, however, that the hypothesis propounded by Bird is not in harmony with the views of most authorities on the subject, for it is commonly believed that the eggs must obtain entry into the stomach, in order that their shells shall be digested, and the enclosed embryo released. Whether this be so or not must, for the present, be regarded as uncertain, for although the statistics of Australian cases apparently lend support to Dr. Bird's views, yet it must be borne in mind, that in countries where Hydatids are comparatively rare, a greater number of lung than of liver cases may escape recognition, and this may be the cause of the smaller ratio of lung to liver cases recorded in Europe.

As to the causes which influence the seat of Hydatids in the body, it may naturally be supposed that the liver becomes the most frequent seat of these cysts, because the embryos, after finding their way into the portal vein, here meet with the first obstruction to their passage through the capillary system; but many do find passage through it, and travelling through the inferior vena cava, enter successively the right auricle and ventricle of the heart, and thence by the pulmonary artery reach the pulmonary capillaries, where, again, a considerable number abide; others run the gauntlet of this second obstruction, and pass by the pulmonary veins into the left side of the heart, and subsequently become conveyed by the current of the systemic circulation to the most remote and varied parts of the body of their host.

It is probable, however, that this simple and almost mechanical explanation does not convey the whole truth, for it is notorious that every cystic Tapeworm has certain chosen seats; thus Cysticercus affects the cellular tissue and the eye, Cœnurus the brain in sheep, &c., and so, probably, has Echinococcus its more and less congenial habitats.

The following table, in which the records of Hydatids from European, Australasian, American, and Indian sources have been taken together, will show the relative frequency of the infection of the different organs of the body, in a total number of one thousand eight hundred and ninety-seven cases.

Table of 1,897 *Cases collected from European, Australasian, American, and Indian Sources, showing the Proportion in which the various Organs and Tissues were Invaded by Echinococcus.*

Locality of Cyst.	Number of Cases.	Percentage of Total Cases.
I.—*Organs of the Abdominal Cavity.*		
Liver	1,084	57·142
Peritoneum, omentum, and mesentery	26	1·370
Kidney	90	4·744
Spleen	40	2·108
Stomach	1	·052
"Elsewhere in abdominal cavity"	35	1·845
In the true pelvis	40	2·108
Uterus	29	1·528
Ovary	16	·843
Bladder	1	·052
Prostate gland	1	·052
Total	1,363	71·844
II.—*Organs of the Cavity of the Thorax.*		
Lungs	220	11·597
Pleura	19	1·001
Mediastinum	4	·210
Heart and organs of circulation	35	1·845
Pericardium	2	.105
"Thorax"	1	·052
Total	281	14·810
III.—*Connected with the Nervous System.*		
The Brain: its membranes and the cranial cavity	83	4·375
The Spinal Cord: its membranes and the spinal canal	15	·790
Total	98	5·165
IV.—*Organs of Locomotion.*		
Muscles	13	·685
Bones	31	1·634
Total	44	2·319
V.—*Sub-cutaneous Cellular Tissue*	21	1·107
Abdominal wall	2	·104
Trunk and limbs	20	1·054
Face, orbit, mouth	21	1·107
Neck	10	·527
Total	74	3·899

Table of 1,897 *Cases, &c.*—continued.

Locality of Cyst.	Number of Cases.	Percentage of Total Cases.
VI.—*Male Organs of Generation**	6	·316
Testis	1	·052
Total	7	·368
VII.—*Female Mamma*	20	1·054
Total	20	1·054
VIII.—*Miscellaneous.*		
Vomited	2	·104
Expectorated	2	·104
Discharged from the intestines	5	·263
In the common bile-duct	1	·052
Total	10	·523

Summary.

	Percentage of Total Cases.
Hydatids connected with the abdominal cavity	71·851
" " " " thoracic "	14·810
" " " " nervous system	5·165
" " " " sub-cutaneous tissue......	3·901
" " " " organs of locomotion......	2·319
" " " " female breast......	1·054
" " " " male generative organs......	·368
Miscellaneous	·523
Total	99·991

The Influence of Age upon the Probability of Hydatid Infection.—No age is necessarily exempt from Hydatid disease, for whenever the ripe eggs of Echinococci are swallowed, infection will follow. But the chances of infection of young children and infants are comparatively small.

A suckling babe is very unlikely to receive infection in any way, and yet Cruveilhier mentions the case of a child, aged twelve days, that appeared to have a Hydatid cyst, but, in this instance, there were strong reasons for doubting whether the observation was correct. The present writer has however recorded the case of a child, aged two years and one month, where a hydatid of the

* Principally in the Scrotum.

liver was operated on by him.* Bodson† found Hydatids in the liver of a girl four years old, and Archambault ‡ in a child seven years old, who had suffered from the disease for fifteen months.

Old age gives no exemption, for Monod§ met with the disease in a man aged seventy-seven; and Charcot¶ saw a Hydatid in a phalanx of the index finger of a man eighty-one years old.

From the natural history of the disease it is evident that, other things being equal, the longer a person lives the greater his chances of becoming infected with Echinococcus, and consequently, we find that more than 80 per cent. of the deaths from this cause, in the Australasian colonies, occur between the ages of twenty and fifty, and that the percentage proportion of deaths rises with each decade of life, up to fifty, after which there is a rapid decrease in the number of persons living to take the infection.

This is evident, upon inspection of the following table and diagram, which show the percentage proportion of deaths from Hydatids occurring in each decade of age, and also the proportions per cent. of persons living in each decade of age, to the total of all ages. The latter figures are the mean deduced from the census of April 3rd, 1881, taken in Victoria, South Australia, New Zealand, and Tasmania; the census returns of Queensland and New South Wales not being procurable by the author.

Age in Decades.	Proportion per cent. of total Deaths from Hydatids.	Proportion per cent. of Persons Alive in each Decade of Age, to the Total Number of all Living Persons.**
Under 10 years old	7·571	27·390
From 10 to 20 years old	10·725	22·277
" 20 " 30 "	18·612	17·227
" 30 " 40 "	20·977	11·465
" 40 " 50 "	21·924	9·890
" 50 " 60 "	13·564	6·552
Over 60 years old	6·782	5·110

In the diagram on the opposite page, **the proportion of persons alive** is indicated by the **blue** lines; the proportion of **deaths from Hydatids** by the **red** lines.

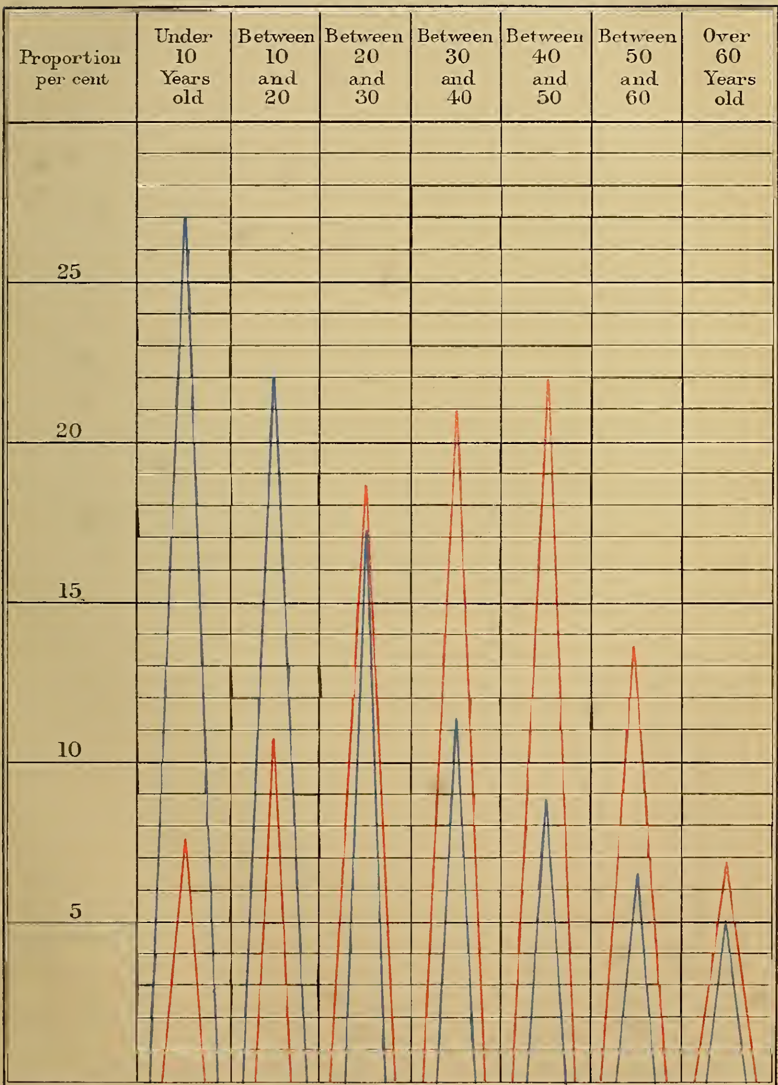
* Upon the occurrence of Tænia Echinococcus in the dog and its relation to the prevalence of Hydatid disease in Australia. By John Davies Thomas, M.D. (Lond.), F.R.C.S. (Eng.) *The Australian Medical Journal*, October 15th, 1882, p. 438.

† ‡ § ¶ Cited by Davaine. Traité des Entozoaires, Paris, 1887, p. 387.

** Mean deduced from the 1881 census returns of Victoria, South Australia, New Zealand, and Tasmania.

DIAGRAM

ILLUSTRATING THE FIGURES IN TABLE on Page 126.



(To face Page 126)

E. Spiller, Lith

PART IV.

THE GEOGRAPHICAL DISTRIBUTION OF ECHINOCOCCUS DISEASE.

PART IV.—THE GEOGRAPHICAL DISTRIBUTION OF ECHINOCOCCUS DISEASE.

In all probability, Echinococcus has as wide a distribution in space as it has had in time, and it will probably be found to exist, with greater or less frequency, in all places where man and his faithful friend and companion, the dog, are found together.

Up to the present time, reliable statistics showing the prevalence of hydatid disease in most of the civilised countries of the world are conspicuous by their absence.

Enough, however, is known to prove that this parasite flourishes under almost all climatic conditions. From Great Britain to America, from Denmark to Bengal, from Iceland in the North to New Zealand in the South, may this ubiquitous parasite be found ; but its occurrence is by no means equally frequent in all places.

Climate *per se* seems to exert no direct influence upon the spread of echinococcus infection, for it is curious to note that chilly Iceland and sunny Australia prove equally congenial climates to this unwelcome immigrant.

It is much to be regretted that more full inquiry into the extent and geographical distribution of this important parasitic disease in the various countries of Europe has not been made.

The data at the disposal of the writer are, unfortunately, very scanty as concerns European countries ; they are, however, much more satisfactory as regards the various colonies of Australasia.

GREAT BRITAIN.

Dr. Cobbold * refers to the defective evidence supplied by the returns of the Registrar-General in respect to Echinococcus disease, and he points out that the blame should be attached, not to the department under the control of that officer, but to those

* Parasites: a Treatise on the Entozoa of Man and Animals. London, J. & A. Churchill, 1879, p. 258.

who supply the certificates of the cause of deaths. A glance at the subjoined table, copied from Cobbold, will show how well justified his criticisms are:—

Deaths from Worms in England and Wales.

	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.
Total	172	148	151	160	154	183	188	227	204	225
Including—										
Porrigo	15	13	9	9	9	14	5	16	7	13
Scabies	6	2	7	1	4	2	—	5	2	3
Tapeworm..........	8	3	6	3	5	3	5	5	2	6
Hydatids	20	20	33	37	41	34	29	43	31	51

It certainly is difficult to conceive upon what biological principle deaths from Porrigo and Scabies are referred to "Worms," and Cobbold remarks :—

"Now, death from Tænia is certainly a very rare occurrence, although "grave nervous symptoms are not unfrequently due to its presence in "man. Thus I am inclined to regard the forty-six reported instances of "death from this cause as a redundant estimate. On the other hand, I "am surprised to see no specified instances of death from Lumbricoid "Ascarides, from Oxyurides, or even from Cysticerci, which now and "then take up their residence in the human brain.

"As regards Hydatids, I believe the returns to be excessively deficient. "In place of an average of thirty-four deaths annually from this cause "in the United Kingdom, I am of opinion that at least 400 deaths are "due to Hydatids. This opinion, and the data on which it was founded, "were communicated by me twelve years ago to the Linnean Society, "and I have since become acquainted with facts which lead me to con-"clude that my original estimate was very much below the mark. The "*post-mortem* registrar of one of our large hospitals has told me that of "late years as many as *ten* deaths might be reckoned as annually due to "Hydatids in their institution alone. At a smaller hospital I ascer-"tained that the average was about *four*. Obviously, if these estimates "are correct, the Registrar-General's returns for the United Kingdom do "not record a tithe of the annual mortality due to hydatids."

The opinion thus expressed by so distinguished an authority as Dr. Cobbold must necessarily carry great weight; still, it appears to the present writer that it would be interesting to note the number of deaths attributed to Hydatid disease in England and Wales during the decade 1871-1880, as deduced from the published returns of the Registrar-General for those years.

Table showing the Number of Deaths returned as due to Hydatid Disease in England and Wales during the decade 1871–1880.

Year.	Deaths from Hydatids.			Deaths from all Causes.		
	Males.	Females.	Total.	Males.	Females.	Total.
1871	—	—	37	265,563	249,316	514,879
1872	—	—	41	255,135	237,130	492,265
1873	—	—	34	254,985	237,535	492,520
1874	—	—	29	272,178	254,454	526,632
1875	—	—	43	282,202	264,251	546,453
1876	13	18	31	265,076	245,239	510,315
1877	—	—	51	260,567	239,929	500,496
1878	28	31	59	278,772	261,100	539,872
1879	22	29	51	271,496	254,759	526,255
1880	21	39	60	273,442	255,182	528,624
			436	2,679,416	2,498,895	5,178,311

This shows that one death out of 11,876 was due to Hydatid disease during the ten years over which the table extends.

There is a second source from which it appeared to the author that information bearing upon this point might be gleaned, viz., the annual statistical records of the various London and provincial hospitals of Great Britain.

Accordingly, about five years ago, circulars, accompanied by suitable printed forms, seeking information upon the subject in question, were forwarded by him to nearly all the chief London and to many of the leading provincial hospitals.

Unfortunately, replies were received in only two instances, viz., from the London Hospital and from the Bristol Royal Infirmary.

The return from the former institution extends over the five years, 1876 to 1881, and it shows that, during this time, twenty-four cases of Hydatid disease were treated, amongst a total of 13,297 *medical* in-patients.

The return of the Bristol Royal Infirmary includes only the year 1880. One case of Hydatid (in the left pectoral muscle) was treated.

However, through their published annual reports, access has been obtained to the statistics of the following London Hospitals:—St. Bartholomew's, for twenty-one years; St. Thomas's for eleven years; and St. George's for thirteen years. Their statistics are given in the following tables:—

ST. BARTHOLOMEW'S HOSPITAL, LONDON.

Table showing the Number of Cases of Hydatid Disease treated to their termination by "Discharge" or Death.

St. Bartholomew's Hospital Reports.	Year.	Total number of In-patients (Medical and Surgical) Discharged.	Cases of Hydatids.	Remarks.
Vol. I.	1860	5,686	3	No details are recorded about cases of Hydatids.
" I.	1861	5,602	0	No details are recorded about cases of Hydatids.
" I.	1862	5,430	2	No details are recorded about cases of Hydatids.
" I.	1863	5,390	4	No details are recorded about cases of Hydatids.
" I.	1864	5,556	6	In two cases "abscesses" due to Hydatids; once in pectoralis major, once among the muscles of the thigh; in a third case a Hydatid was removed from the serratus magnus muscle.
" II.	1865	5,071	3	
" III.	1866	4,525	2	
" IV.	1867	5,170	4	
" V.	1868	—	—	Annual statistics not published for this year.
" VI.	1869	5,124	6	Including one case under the latissimus dorsi muscle.
" VII.	1870	5,090	9	The liver in eight cases, the brain in one instance, were the seats of the parasite.
	In 10 yrs.	52,644	39	=One Hydatid to 1349·84 of total In-patients, or ·074 per cent.

Vol. VIII.	1871	5,687	10	One in brain; six in the liver; one in cellular tissue behind the prostate; one over the biceps muscle; one at the back of the neck.
" IX.	1872	5,528	6	Five in liver, and one in liver and spleen.
" X.	1873	5,339	8	Seven in the liver (not including two re-admissions of one case). In one case a man died of empyema, due to the rupture of a Hydatid into the pleura.
" XI.	1874	5,777	6	All in the liver.
" XII.	1875	5,550	3	All in the liver.
" XIII.	1876	6,195	7	Six in the liver, one in the kidney.
" XIV.	1877	4,780	4	In one case Hydatids in liver, omentum, and Douglas' pouch.
" XV.	1878	5,159	8	All in liver. In one case, occlusion of the common and cystic bile-ducts by Hydatids.
" XVI.	1879	5,838	6	Four in liver only; one in liver and lung; one suppurating Hydatid in the cellular tissue.
" XVII.	1880	6,529	4	All in liver.
	In 10 yrs.	56,382	62	=One Hydatid to 909·38 of total In-patients, or ·109 per cent.
" XVIII.	1881	6,376	7	In one case, Hydatids in liver and peritoneum, with discharge of cysts per rectum and per vaginum. In one case, discharge of cysts through the bladder. In one case, a carman, *æt.* 33, pulled up his horse suddenly, said he had ruptured himself, and died in a few hours. *Post-mortem*—ruptured cyst in the peritoneum. In one case, Hydatid of thigh.
	In 21 yrs.	115,402	108	=One Hydatid out of 1068·53 total In-patients, equal to ·0935 per cent.

ST. THOMAS'S HOSPITAL, LONDON.

Table showing the Number of Cases of Hydatid Disease treated to their termination by "Discharge" or Death.

Year.	Total number of In-patients (Medical and Surgical) Discharged or Died.	Cases of Hydatids Discharged or Dead.	Remarks.
1871	1,700	2	"Hydatid Abscess."
1872	3,289	4	Five are recorded in the report, but one was a re-admission.
1873	2,866	7	One in brain; one in spleen, death due to renal disease; five in liver, death in one case from chronic renal disease.
1874	2,938	8	One supposed to be a psoas abscess and another cystic ovarian disease.
1875	2,989	3	Two Hydatids of the trunk. N.B.—This year's medical report is incomplete, in consequence of the death of the medical registrar.
1876	3,147	4	
1877	3,248	5	One of the lung, four of the liver.
1878	3,183	3	
1879	3,351	2	Three are mentioned in the annual report, but one was a re-admission.
1880	3,838	3	One in the liver, cysts discharged per anum; one in the thigh; one case of omental Hydatid, treated by abdominal section, died.
1881	4,010	3	All in the liver.
In 11 yrs.	34,559	44	=One Hydatid to 785·43 of total In-patients, or ·127 per cent.

Note.—In the annual reports for the years 1866-1870, inclusive, details of "Liver enlargements" are wanting, but in 1868 one patient, who died of phthisis seven weeks after admission, was found to have a Hydatid cyst on the under surface of the liver, close to the gall-bladder.

ST. GEORGE'S HOSPITAL, LONDON.

Cases of Hydatid Disease under treatment.

Year.	Total number of In-patients treated (Medical and Surgical).	Cases of Hydatids treated.	Remarks.
1865	3,779	1	P.M., a Hydatid of the liver found in a case of phthisis.
1867	3,708	2	
1868	3,710	3	Two in the liver; one in the lung, which was ruptured by a fractured rib.
1870	3,682	3	Two in the liver; one in the substance of the sacrum.
1871	3,239	1	In the liver.
1872	3,718	1	In the liver.
1873	3,731	1	In the liver.
1874	2,687	0	
1875	3,745	2	
1876	3,153	5	Four in the liver, of which one case was found only by *post-mortem* examination; one in the spinal canal and abdomen.
1877	3,252	1	In liver and pelvis.
1878	3,575	0	
1879	3,620	2	One in the spleen, operated on; one old cyst found *post mortem* in the liver.
In 13 yrs.	45,599	22	=One Hydatid to 2072·68 of total In-patients, or ·0482 per cent.

Summary of Returns of Three London Hospitals.

Name of the Hospital.	Number of Years included in the Tables.	Total Number of In-patients treated (Medical and Surgical).	Number of Cases of Hydatids.	Ratio of Hydatid to other Cases.	Percentage Ratio of Hydatids.
St. Thomas's....	11 years	34,559	44	1 to 785·43	·127
St. Bartholomew's	21 "	115,402	108	1 to 1068·53	·0935
St. George's	13 "	45,599	22	1 to 2072·68	·0482
Three London hospitals	45 years	195,560	174	1 to 1123·90	·089

It will be observed that the proportion of cases of Hydatid disease in these hospital returns varies widely, there being, for example, nearly three times as large a proportion in St. Thomas's as in St. George's Hospital. This is probably to be explained by the supposition that more ample statistical details are given in the reports of the former hospital, for it seems to be very unlikely that the actual ratio of such cases should vary much in hospitals situated in the same city.

It is to be hoped that a more extensive investigation of this matter will be undertaken by some observer resident in Great Britain; meanwhile we shall probably not err much in estimating that in the hospitals of London, about one In-patient out of a thousand has, or has had, Hydatid disease in some organ, although it is by no means always the direct cause of the patient's death.

Murchison* states that "Out of 2,100 *post-mortem* examinations re- "corded at the Middlesex Hospital between April 19th, 1853, and August "25th, 1863, Hydatids were found in only thirteen, or once in 161, "and in only seven of the thirteen cases, or once in 300 cases, were they "the cause of death."

He also adds that hydatids are much rarer in Scotland than in England.

Dr. Scott Orr has searched the records of the Glasgow Royal Infirmary from the earliest periods, but has only found three cases, one in the mamma, and two in the liver ("Glasgow Med. Journal," January, 1876). Dr. Gairdner also states that among many thousand dissections which he had either performed, or seen performed, during his connection with the Edinburgh Royal Infirmary, in only one instance had a Hydatid been found in any part of the

* Clinical Lectures on Diseases of the Liver; second edition, London, 1877, p. 55.

body, and that was in the upper part of the right lung. The patient came apparently from Newcastle. ("Clinical Medicine," p. 431.)

GERMANY.

According to Neisser,* the occurrence of Hydatid disease in the hospitals of several towns, for some years prior to the publication of his work, was ascertained to be as follows:—

Name of Town.	Total Number of Patients Treated.	Number of Cases of Hydatid Disease.	Per Cent.
Breslau	85,062	20	0·023
Vienna	369,713	38	0·012
Nürnberg	15,500	none	—
Hamburg	18,000	none	—
Würzberg	10,000	rare	—
Leipzig	during the years 1852-69	19	—
Jena	—	1 annually	—

Table showing the Number of Cases in which Hydatid Cysts were Discovered during the performance of Post-mortem Examinations.

Name of Town.	Number of Autopsies Performed.	Number of Instances in which Hydatids were Found.	Percentage.
Berlin	4,770	33	0·691
Dresden	168	2	1·190
Göttingen	639	3	0·469
Rostock	261	12	4·591
Prague	1,287	3	0·233
Vienna	1,229	3	0·244
Zürich	400	0	—
Breslau	5,128	39	0·761

FRANCE.

Davaine† quotes M. Leudet, who gave it as his experience that Hydatids were more common in Rouen than in Paris. Out of nearly 200 autopsies performed by Leudet at the Surgical *Clinique* at Rouen, Hydatids were present in six cases.

During six years of service as *interne* at Paris, a far smaller proportionate number of Hydatids came under his notice.

* Die Echinococcen-Krankheit. Berlin, 1877, p. 36.

† Traité des Entozoaires, Paris, deuxième édition, 1877, page 389.

SWITZERLAND.

In Zurich, Lebert found, among 200 autopsies, no example of Echinococcus. In the face of this it is a remarkable circumstance that, out of the thirty-five cases of Multilocular ulcerating hydatid collected by Klebs, Marie Prougeansky, and Morin, no fewer than nineteen were found in Switzerland.

Hydatid disease occurs occasionally in Italy and Denmark, but apparently no data exist by which to estimate its frequency in these countries.

ICELAND.

This country has long had the unenviable fame of being that in which Echinococcus spreads its worst ravages, both in man and beast.

Krabbe, who was deputed by the Danish Government to investigate and report upon the subject, published the results of his inquiry in 1866.

He stated that it was only for about a century past that a body of properly educated medical men had existed in Iceland; nevertheless, there was great reason for believing that this disease had been as prevalent for centuries past in Iceland as it was known to be at the time of his visit.

The first medical officer appointed to the sanitary service was Bjarne Povelsen, in 1760. This physician, however, refers only vaguely to the disease, under the title of "*Malum hypochondriacum*," and he states that it was known to the common people by the term "*Briostveike*" (chest-complaint). Subsequently, John Petersen and John Svendsen made allusions to the same malady.

In 1803 the Danish Government issued orders that sanitary reports should be supplied annually by the district medical officers, both in Denmark and in Iceland. Those from the latter country constantly refer to Hydatid disease as prevalent in all parts of the island, but it is referred to rather as a local disease of the liver, under the names "*Hepatalgia*," "*Hepatitis chronica*," "*Infarctus*," "*Hypertrophia hepatis*," &c., than as a parasitic affection.

So little was the nature of the malady understood, that Fenger, in 1843, remarks, with surprise, upon the circumstance that "chronic hepatitis," which constitutes one of the most characteristic diseases of hot countries, and which in temperate climates

becomes more and more rare as one approaches the north, should again manifest itself so far north as Iceland, with a violence unknown perhaps even in the tropics.

Schleisner, who travelled over Iceland in 1847-48, seems to have been the first writer who clearly recognised the true nature of the disease, for he remarks that "it is a disease caused by entozoa, "which develop not only in the liver, but also in the whole "organism."

The subject was afterwards more closely investigated by Eschricht, in 1853.

Very varied accounts have been given by different writers as to the prevalence of the disease.

Thus, Schleisner stated that "among the 2,600 sick who appeared in the medical reports, there were 328 or about $\frac{1}{8}$, and "among the 327 under his personal care, fifty-seven, or more than "$\frac{1}{6}$, in whom the liver was attacked" by Hydatids

Thorstensen, who practised in Iceland for more than twenty years, estimated that one-seventh of all the inhabitants had Hydatid disease.

Gerault, who wrote in 1857, remarks that the returns supplied to the Danish Government showed that not less than one-fifth of the entire population was infested with Echinococcus.

Eschricht's estimate was one-sixth.

Other good authorities regard these estimates as too high; thus Finsen, who paid especial attention to this matter from 1857 to 1862, recorded that in the district of Ofjord, where he resided, and which had a population of about 4,500 inhabitants, he treated, on an average, 596 sick persons per annum, of whom sixteen or about $\frac{1}{38}$ were Hydatid cases, and he was acquainted in this district with seventy-seven living persons who had then, or who had had, this complaint, *i.e.*, about $\frac{1}{58}$ of the entire population.

In the district of Thingo, which reckoned 5,500 persons, the proportion of Hydatid to other cases of disease was $\frac{1}{21}$, and there Finsen knew forty-two persons attacked by this parasite, or $\frac{1}{130}$ of the district population.

Dr. J. Hjaltelin,* the late chief physician of Iceland, wrote in 1869:—

* Reports on the Progress of Practical and Scientific Medicine in different parts of the World. Edited by Horace Dobell, M.D. London, 1869, p. 287.

"That the endemic Echinococci are very frequent in this country, both "in men and domesticated animals, especially in sheep, is unquestionable, "but their statistical frequency cannot, at present, be stated with any re- "liable certainty. The late chief physician of this island, Dr. Thor- "steinson, who had paid a good deal of attention to this subject during "his long career as the chief medical officer of Iceland, held that about "every sixth or seventh of all the Icelanders were affected with Echi- "nococci.

"One physician still living in the north part of this country, Dr. "Skaptason, who has practised there during a period of more than thirty "years, is of the same opinion. The third district physician, who has "served for thirty-two years, viz., Dr. Thoraensen, and made himself "famous by treating some cases of Hydatids with electricity, fully agrees "with the aforesaid opinion of Dr. Thorsteinson on the subject.

"I myself feel inclined to the same opinion, although Dr. J. Finsen "holds a very different view, for, from his nine years' experience, he "says that out of 7,539 cases of disease treated by him, 280 were "Echinococci, or 1 in 26·9.

"This, I think, is rather too low, although it is at present, for the "want of hospitals, very difficult to obtain any statistical proof on this "question. According to the results of many autopsies made here in "Reykjavik during the last ten years, hydatids have been found in every "sixth body; this, however, is no conclusive proof of the frequency of "this chronic malady, for many have died from hydatids who were not "examined, although, on the other hand, Echinococci have been found "in some dead bodies where they were not known to exist during life. "Of all the cases treated in our hospital this year, nearly every fifth has "been a case of Echinococci, either external or internal, and of the many "cases treated by myself, during the last two years, even more than one- "tenth have been Echinococci."

Even allowing for the discrepancies in these various estimates, the main fact stands out clearly, viz., that there is in this country a most extensive endemic distribution of this dangerous parasite.

ALGIERS.

The French military surgeons have frequently observed Hydatids, both in the French soldiers and in the natives of the country. Dr. Vital met with a dozen instances in the hospital of Constantine.*

EGYPT.

Bilharz met with three cases of Hydatid of the liver.

* Davaine, loco cit., p. 389.

BRITISH INDIA.

Hydatid disease is not common in India, and Budd remarks that those authors who have written on the prevalent diseases of the country make but rare references to the malady.

Thus Dr. Morehead met with but two cases there, one of which had been developed in Europe.

The correctness of the opinion that Echinococcus disease is rare in India is well borne out by official records, courteously supplied to the writer by the Indian Government, at the request of the Government of South Australia.

In reply to a request for information upon this subject, F. C. Daukes, Esq., Under Secretary to the Government of India, forwarded copies of documents as follows :—

1st. A memorandum from S. Crawford, Esq., Surgeon-General of Her Majesty's forces, dated Simla, October 24th, 1881, to the effect that no information would be likely to be gained by circulating the form referring to hydatid disease in the military hospitals of that command.

2nd. J. M. Coates, M.D., writing on behalf of the Surgeon-General for Bengal reported : "That the records of the principal "hospitals of the Presidency do not show any case of hydatid "disease, except two cases in the General and Mayo Hospitals. "The statements submitted by the superintendents are herewith "forwarded." These were—

(A)—*A Table showing the Admissions and Deaths from Hydatids in the European and Native Armies and Gaols of India, for the years* 1870-79.

	Cysts of Liver.		Hydatid of Liver.		Hydatid of Brain.	
	Admitted.	Died.	Admitted.	Died.	Admitted.	Died.
European army	5	—	2	—	—	1
Native army	—	—	—	—	—	—
Gaols	2	—	1	—	—	1

Note.—There were no admissions or deaths in the native army from Hydatid disease during this period. (Signed),

Simla, 19/10/81. A. STEPHEN, Statistical Officer.

(B.)—*Cases of Hydatids Treated in the Mayo Native Hospital, during* 1876 *to* 1880, *inclusive.*

CLASS A., SINGLE CYSTS.
None.

CLASS B., MULTIPLE CYSTS.
In liver only.—Male, 1; total, 1; died, 1.

(Signed) H. CAYLEY, Surgeon-Superintendent,
Mayo Native Hospital.

(C.)—*Cases of Hydatid Disease Treated in the Presidency General Hospital during the years* 1876 *to November,* 1881, *inclusive.*

CLASS A., SINGLE CYSTS.
None.

CLASS B., MULTIPLE CYSTS.
In liver only.—Male, 1; total, 1; died, 1.

(Signed) J. JONES, M.D., Surgeon-Major,
Surgeon-Superintendent.

Dr. A. Christison, the Surgeon-General, North-West Provinces and Oudh, writing under date Lucknow, November 4th, 1881, to the Surgeon-General with the Government of India, states that no information of the kind requested could be supplied from his office, and adds that "As far as has been ascertained by inquiry from ex-"perienced medical officers, Hydatid disease is not met with in these "provinces."

THE PUNJAUB.

Surgeon-General S. C. Townsend, C.B., writing under date Lahore, February 1st, 1882, states that:—

"No Hydatid diseases have ever been recorded at Amritsar or Pesha-"wur: Extracts from reports by the Principal, Mayo Hospital, and the "Civil Surgeon, Delhi, are inclosed for information, together with copy "of letter, No. 139, dated January 24th, 1882."

The letter referred to is as follows:—

"From the Principal, Lahore Medical School, to Dr. S. C. Townsend, "C.B., Surgeon-General with the Government of the Punjaub.

"In answer to your office letter ————, I have the honor to for-"ward the following information respecting the occurrence of Hydatid "disease in Lahore:—

"From a careful examination of our registers, from the year 1863 to "the year 1881, I find that only four cases of hydatid disease have been "diagnosed among the patients in the Mayo Hospital and the Charitable "Dispensary, Lahore. These occurred as follows:—

"1st case, 1867; admitted April 26th.—Hossaini, a female with "Hydatid of the liver; left, said to be cured, on the 13th May, 1867.

" 2nd case, 1877.—A male Hindu named Radha Kishen; admitted " on the 29th May with Hydatid disease of the liver; left the hospital, " cured, on the 15th June, 1877.

" 3rd case.—Alladilla, a Mahomedan male; admitted into the hos- " pital on the 11th January, 1878; left relieved, but not cured, on the " 10th of February, 1878.

" 4th case.—Nawab, a Mahomedan male; admitted the 2nd of April, " 1881, for cataract; died on April 6th; Hydatid found in the brain."

Only these four cases have been registered out of the attendance during nineteen years; the total number of in-patients who have been treated in that time was 25,579, being in the proportion of 1 in 6,399 patients.

" But, in addition, a certain number of preparations are contained in " the museum of the Medical School, illustrating hydatid disease.

" 1. Hydatid on upper surface of liver of a man, sent on the 15th " January, 1878; the patient died in the Mayo Hospital.

" 2. Hydatid cyst in the brain of a man; the patient died in the " Mayo Hospital on the 14th December, 1875; not diagnosed during " life; the cyst existed in the right lobe of the brain, and had caused a " depression on the skull.

" There are also the following specimens, sent to the museum from " other parts of the province.

" 1. Specimen of Hydatid disease of the liver; a single cyst on the " under surface of the liver. Sent by the Civil Surgeon, Rawal-Pindi, on " the 8th October, 1868.

" 2. Hydatid cysts of the liver; two Hydatid cysts on the under sur- " face of the liver of a man. Sent on June 4th, 1869. No record of " this case.

" 3. Two Hydatid cysts in the liver and one in the spleen of a man, " received from the gaol, at Rupar, on the 16th December, 1876.

" 4. Hydatid cysts found in the liver, lungs, and spleen of a sheep. " In this specimen several small cysts were in the liver and lungs, and " two larger ones in the spleen. Received from the Superintendent of " the Central Gaol, Lahore, on the 25th of January, 1878.

" These are all the cases of Hydatid disease that I have been able " to trace."

THE DELHI CIVIL HOSPITAL.

Ramkishen.—Assistant-Surgeon reports:—No cases of Hydatid cyst have been observed in this hospital, either in the wards, among the outdoor patients, or in the P.M. room. One case, returned as Hydatid of the Brain, was also a doubtful one, as the man came only once or twice as an out-patient to the hospital.

No information as to the occurrence of Hydatid disease in the Bombay or Madras Presidency has reached the writer up to the present time.

In curious contrast with the rarity of Echinococcus disease in man, is the frequency of the infection of the domestic herbivora, in some parts at least, of India. See Part V. of this work.

AMERICA.

Davaine* remarks that Hydatids "are very rare in the United "States," and adds that Leidy, in his "Synopsis," mentions but two cases of this kind. One, which occurred in the son of an English sailor, and a second in a Frenchman. He adds that he had never seen such a case in an Anglo-American.

In reply to an inquiry made by the writer, the Secretary of the National Board of Health, writing under date Washington, February 13th, 1882, reported that the only information respecting Hydatid disease in America, procured up to that date, was that supplied by Dr. Morris Longstreth, Physician and Pathologist to the Pennsylvania Hospital, Philadelphia.

Dr. Longstreth writes:—

"I enclose you printed slips from the museum catalogue of the Penn-"sylvania Hospital, containing a description of three cases of Hydatid "cysts; you will perceive by the names of the patients their nationality, "two French and one Italian. Neither of them had been in our country "long, and they spoke the English language very imperfectly.

"The first case (1382^{50}) bears evidences of four cysts, one in the left "lobe, which had evacuated through the lung, the two found in the liver, "and the one in the pelvis. The microscope showed Echinococcus "hooklets, which is not stated in the print, but was stated in the Trans. "Path. Society's notice.

"In the second case (No. 1382^{55}) there are few cysts; they were all "dead and inactive, and partly calcified. There was no evidence of "their presence during the man's life, and he died a day or two after "admission, of pneumonia, complicated with Bright's disease.

"The third case (1832^{60}) is a very interesting one. No diagnosis of "hydatid was made during life, although my colleague, Dr. Hutchinson, "under whose care the patient was, discussed the possibility of this "nature of the case; a careful examination of the stools was made during "life, but nothing was found; gallstones were looked for, but it is certain "that no hydatid membrane passed; it is not probable that any passed "per anum, as the quantity found in the cyst cavity and the duct,

* Op. cit., p. 389.

"together with the few shreds in the intestine, would quite fill the space "in the liver tissue.

"These cases all came under my personal inspection during life, and "I also made the *post-mortem* examinations.

"These are all the cases which the hospital register shows to have "been admitted into the hospital, or which have come to *post-mortem* "examination."

The following is a copy of the printed slips referred to by Dr. Longstreth :—

"1382[50]. Hydatid Cyst from Liver.—The specimen shows the "membranous shreds from a large hydatid cyst of the liver.

"Case of a Frenchman admitted to the hospital February 8th, 1871. "He had suffered during a number of years from a chronic diarrhœa and "other disturbances, which had been assigned to the liver. Four years "previous to admission, he had been suddenly seized, without any "assignable cause, with intense pain in the right chest, with dyspnœa "and expectoration of a peculiar yellowish matter mingled with blood, "in such abundance that he was nearly suffocated by it. The symptoms "in the chest rapidly disappeared, and it was thought that an abscess had "evacuated itself through the lung. Recently the abdomen had "gradually become distended; he had had constant pain in the epigastrium "with tenderness on pressure. He also suffered from a distressing sense "of weight in the lower belly, and an incessant inclination to go to stool. "Vomiting constantly followed the taking of food, and during the last "six weeks he had been confined to his bed. On admission he was pale, "sallow, and slightly jaundiced. There was great enlargment of the "lower part of the chest and of the abdomen, particularly on the right "side. The liver dulness was greatly increased, and in the median line "a small projecting mass or nodule was obscurely felt. In the hypogas- "trium there was a sense of resistance on palpation, but no distinct "tumor could be detected. He was unable to pass water, and a flexible "catheter, though passed to a great distance, was unable to reach the "bladder. He died in less than forty-eight hours after admission. At "the autopsy, the right pleural cavity was found almost entirely ob- "literated by old adhesions. The liver was greatly enlarged, and ad- "herent on its convexity to the diaphragm. It presented an immense "whitish-yellow tumor, occupying the whole extent of the lobe and taking "wholly the place of the hepatic tissue. It fluctuated on palpation, and "was found to be an immense hydatid cyst, containing about three quarts "of yellowish-white, turbid fluid, containing hundreds of daughter "cysts, varying in size from a pea to a hen's egg. On the anterior sur- "face of the liver, about the middle of the organ, is another cyst, "resembling the first on its exterior, and about the size of a small orange. "At the left edge of the left lobe is a large puckered indentation showing "a thick yellow cicatrix. The kidneys showed slight amyloid degenera- "tion. *The bony pelvis was completely filled with a large white, tense,* "*thin-walled cyst.* It sprang from the connective tissue between the

" rectum and the bladder, posteriorly to the prostate gland. The bladder " was pushed up by, and was lying upon it. It was greatly distended " with clear, pale, distinctly albuminous urine, in which no tube casts " were detected." (See Trans. Path. Soc. Phila., vol. IV., p. 38.)

" 1382[55]. LIVER SHOWING MULTIPLE HYDATID CYST.—The specimen " shows a portion of the right lobe of the liver. On its anterior border, " just to the right of the gall-bladder, is a white, nodular projection, " measuring two and a half inches by two inches in width, about the " size of an orange. The mass in the recent condition fluctuated. It " contained a milky fluid, containing shreds of matter resembling lymph. " The cyst has thick fibrous walls, which, on their outer surface, are " smooth and shining; within, the membrane is rough and shaggy. At " the posterior part of the convexity is seen another cyst, presenting on " the surface an irregularly circular figure about one inch in diameter. " It has a doughy, elastic feeling; its surface is white and smooth, and " level with the surrounding liver tissue. The liver substance has been " cut away around the cyst, leaving it attached only at its inferior part. " The mass is found to be divided apparently into three small cysts, the " largest having the size of a common walnut, the other two that of a " hazel-nut. The liver tissue appears to be normal, but markedly con-" gested.

" Case of Baptiste D. Wilie, *æt.* 70, admitted January 29th, 1876, No. " 1471, suffering from pneumonia and Bright's disease. The autopsy " showed, besides the hydatids in the liver, pneumonic changes in the " right lung, calcareous changes of the aortic and mitral valves, hyper-" trophy of the left ventricle, and contracted kidney."

" 1382[60]. LIVER SHOWING REMAINS OF HYDATID CYST.—The organ " is very greatly enlarged, especially its right lobe. At its posterior " surface, near the middle, is a large cavity three inches and a half in " diameter, with walls made up with condensed liver tissue. From the " lower portion of the cystic cavity are several large openings or minor " cysts. Through one of these the finger can be passed directly into the " hepatic duct, which was enormously dilated, and the connective tissue " and glands surrounding it greatly swollen and enlarged. The gall-" bladder is likewise very much dilated. The opening of the ductus " communis presents a wide patulous mouth, through which a probe can " be passed till it enters the cavity of the hydatid cyst. At the fissure " of the gall-bladder there is a deep indentation, and liver substance is " replaced, in great degree, by thick fibrous tissue. There are numerous " inflammatory adhesions over the upper and back part of the convexity " of the liver, connecting it with the diaphragm.

" Case of Joseph Mazziti, *æt.* 35, admitted March 18th, 1881, No. " 2017, under the care of Dr. Hutchinson. The patient has always been " perfectly healthy until fifteen days prior to admission, when he was " suddenly seized with a sharp pain in the region of the stomach. The " following day he became jaundiced, and the pain gradually extended " around the chest, from behind forwards, over the region of the stomach " and liver. His bowels, at first, were loose, but later became consti-

"pated. On admission, the pain still continued over the back and the "region of the liver and stomach. The jaundice was increasing in depth "of color. He had nausea and vomiting and some febrile movement. "Three days later he had a chill, followed by fever and great increase of "pain. Pleural friction sounds were heard posteriorly, at the base of "both lungs. The following day there was diarrhœa, with black offensive "stools. He died March 24th. The autopsy showed slight peritonitis "pretty generally diffused over the intestines. The right lobe of the "liver extended nearly to the crest of the ilium. Among the intestinal "contents were found several large pieces of hydatid membrane, and from "the opening of the common bile-duct, a very large piece of membrane "was projecting. The hepatic duct, as well as the cavity in the liver, "contained material of the same sort. The microscope showed numerous "hooklets of the Echinococcus."

By the courtesy of Dr. Longstreth, the writer has ascertained that 19,153 patients were treated in the hospital during the period over which the Hydatid returns extend.

The valuable returns supplied by Dr. Morris Longstreth quite confirm the opinion that Hydatid disease is rare in America.

Dr. William Osler,* of Montreal, has recently investigated this subject exhaustively. He states that "in this section of the country "it is rarely met with, and in the inspection of over 800 bodies "only three instances have been found."

From various sources in America, including museums, journals, transactions, and private sources, Dr. Osler has succeeded in collecting sixty-one cases of Echinococcus disease.

The distribution of the cysts was—

Liver	44	Pelvis	4
Spleen	4	Brain	2
Lung	5	Stomach	1
Abdominal wall	2	Sub-cutaneous	1
Bladder	1	In common bile-duct	1
Bones	1	Discharged from intestines	5
Peritoneum, omentum, and mesentery	7	Vomited	2
		Expectorated	2

Dr. Osler remarks:—

"Unfortunately, we cannot say positively how many of these cases "were truly American, *i.e.*, originated here, and how many were im- "ported; but in sixteen it is stated that the patients were Europeans. In "the majority the nationality was not given, but in all probability at "least one-third of the cases were imported, leaving only about forty "native cases. This immunity may be due either to scarcity of the

* On Echinococcus Disease in America, by William Osler, M.D., M.R.C.P. (London), Professor of the Institutes of Medicine, McGill University; Lecturer on Helminthology, Montreal Veterinary College; Physician to the Montreal General Hospital. In the *American Journal of the Medical Sciences*, October, 1882.

"adult worm or to the absence of conditions favorable to the infection of "man. The Tænia Echinococcus is certainly a rare parasite. In some "scores of dogs which I have examined during the past fifteen years, I "have never met with a specimen, nor do I know of its detection by any "American observer."

As Dr. Osler remarks, it probably is really present in dogs to a greater extent than might be supposed from the facts mentioned, for Echinococcus cysts are by no means rare in the lower animals. Osler adds:—

"In casual visits to butchers' stalls and to the shambles, I have ob- "tained six or eight large Echinococci, and I have the liver of a cat with "two large cysts. One of my students, Mr. A. W. Clements, of Law- "rence, Mass., examined 270 hogs in the Montreal abattoir, and found "ten animals affected."

Dr. Dean reports that a considerable proportion of the hogs slaughtered in St. Louis are infested, and Dr. Gross, in his "Patho- "logical Anatomy," 1845, states that one-tenth of the hogs in Cincinnati were at that time affected, and speaks of "whole droves, "consisting of three or four hundred animals, all of which were "diseased in this way."

AUSTRALIA, INCLUDING TASMANIA AND NEW ZEALAND.

It has long been known that Echinococcus disease is very common in some parts of Australia, and references have been made by various writers to its prevalence, especially in Victoria.

Thus, in April, 1861, a paper by Dr. R. F. Hudson, of Ballarat (then Resident Physician to the Melbourne Hospital), appeared in *The Australian Medical Journal.* In this communication, Hudson remarked that Hydatids were becoming common in Melbourne, and he "ventured to predict that Hydatids would become of "frequent occurrence in Australia."

Subsequent experience has proved the soundness of Dr. Hudson's judgment.

In 1867, Dr. W. Lindesay Richardson* made a similar reference to the occurrence of the disease.

Cobbold† gives a table, copied from the Melbourne *Leader*, January 31st, 1874, of the deaths caused by Hydatids in Victoria, during the eleven years 1862 to 1872, inclusive.

* Notes on some of the diseases prevalent in Victoria, Australia. *The Edinburgh Medical Journal*, December, 1867. Article iv., p. 529.

† Parasites, p. 123.

A similar table, including the deaths due to this cause in the decade 1868-1877, inclusive, was published by the present writer in the *Lancet* of March 1st, 1879.*

Impressed with the frequency and gravity of this parasitic affection in the colonies of Australia, the writer has recently endeavored to procure statistical evidence of its extent. Evidently, the two most reliable sources of information are the annual returns of the causes of death received by registrars-general, and the records of the hospitals in the various colonies.

Through the kind influence of the separate Governments, a large amount of information from both these sources has reached the writer, and although it is by no means complete, it is hoped that some practically useful results may follow its publication.

WESTERN AUSTRALIA.

According to Hayter,† the population of this colony, on December 31st, 1881, was 30,013.

In March, 1878, the Colonial Secretary wrote that he regretted his inability to supply information as to deaths from Hydatid disease, because—

"Under the Registration Act of this colony, it is not compulsory on "individuals registering deaths to produce the certificate of a professional "man, consequently causes of death in most instances are recorded in "general terms."

In a more recent communication, addressed to the Chief Secretary of South Australia, the Colonial Surgeon of Western Australia reported—

"That no cases of death have occurred in Western Australia from the "disease in question during the period from 1878 to October, 1882, the "few cases that have been brought under his notice having all been "successfully treated."

VICTORIA.

According to the census taken on April 3rd, 1882, the total population of Victoria was:—

Males	452,083
Females	410,263
Total	862,346

* See also Cobbold. Parasites, Appendix, page 287.

† Victorian Year-Book for 1881-82, folding-sheet No. 3, by Henry Heylyn Hayter, Government Statist of Victoria.

The mean annual death-rate for the twenty years 1861 to 1880, inclusive, was 16·23 per 1,000.*

From the returns courteously supplied by Mr. Hayter, the Government Statist, it appears that during the twenty years, commencing with the year 1862 and concluding at the end of 1881, 584 persons died of Hydatid disease in the province of Victoria. Of these there were—

Males	338
Females	246
Total	584

The details being as shown in the table appended—

Table showing the Numbers of Persons of each Sex that Died in Victoria, from Hydatid Disease, during the Twenty Years 1862 *to* 1881, *inclusive.*

Year.	Males.	Females.	Total.	Proportion of Deaths due to Hydatid Disease.
1862	3	2	5	
1863	3	2	5	
1864	6	3	9	
1865	9	6	15	
1866	18	7	25	
1867	13	12	25	
1868	21	12	33	0·329 per cent.
1869	12	10	22	0·208 "
1870	10	7	17	0·164 "
1871	6	9	15	0·152 "
1872	24	5	29	0·269 "
1873	17	12	29	0·253 "
1874	20	21	41	0·336 "
1875	25	22	47	0·308 "
1876	23	13	36	0·266 "
1877	24	14	38	0.298 "
1878	17	20	37	0·291 "
1879	29	31	60	0·495 "
1880	28	20	48	0·412 "
1881	30	18	48	0·390 "
In 20 years	338	246	584	

For the figures prior to 1868, the writer is indebted to an article in the Melbourne *Leader* for January 31st, 1874.†

The average for the fourteen years 1868 to 1881, inclusive, shows that 2·98 *per* 1,000 *of the total mortality of Victoria was due to Hydatid disease.*

* Hayter. Victorian Year-Book, 1880-81, p. 228.

† See also Cobbold. Parasites, p. 123.

Sex.—The following extract from Hayter* will exhibit the proportion of the two sexes towards the total population :—

"The census of 1881 showed that the sexes in Victoria had attained a "nearer approach to uniformity than had been reached at any previous "period in the history of the colony, or than had been anticipated. The "proportions were 90·75 females to 100 males, or 110·19 males to 100 "females. In 1871 females were in the proportion of 84·4 to 100 males, "and in 1861 of 64·4 to 100 males."

If now we strike an average of the relative proportion of the two sexes for the twenty years, commencing 1861, we shall find that they stand, approximately, thus :—

Males	100
Females	80

The mortality from Hydatid disease in the two sexes stands thus—males, 338; females, 246; or, approximately—

Males	100
Females	74

From this it appears probable that a rather larger proportion of males than of females die of Hydatid disease in Victoria, even after taking into account the disparity in the actual numbers of the two sexes living in the country. This can probably be explained by the circumstance that more men than women are to be found employed on sheep stations and in mining districts, where the water supply is scanty, and, consequently, more liable to contamination by the eggs of Tænia Echinococcus.

Upon reference to the table, it will be noticed that there has been, upon the whole, a constant but somewhat irregular increase in the mortality from Hydatids with advancing time. This is particularly conspicuous when we compare the four quinquennial periods embraced within the twenty years, thus :—

First Quinquennium	1862-67	59 cases
Second Quinquennium	1867-72	112 "
Third Quinquennium	1872-77	182 "
Fourth Quinquennium	1877-82	231 "

This gradual increase is evidently due to one or both of two causes—either Hydatid disease is becoming more prevalent in Victoria, or the Registrar-General is being more accurately informed as to the true causes of deaths.

* Op. cit., p. 22.

But, of course, it must be borne in mind that the population of the colony has increased greatly during these twenty years, viz:—

Population of Victoria in 1862 .... 554,358 souls.
Population of Victoria in 1882 .... 861,346 "

But, then, in the last quinquennium there were nearly four times as many deaths from Hydatids as in the first one, whilst the population was not nearly twice as great.

Age of Deceased Persons.—The subjoined table shows, arranged in decades up to sixty, the ages of the persons who died from Hydatids from 1868 to 1881, inclusive.

It will be seen that no period of life is exempt, but that the number of deaths increases steadily with advancing age up to fifty; afterwards the numbers diminish.

This is not because people are less prone to take the infection as they grow older, but because there are fewer persons alive to become infected.

Table showing, arranged in decades, the Ages of the Persons that Died of Hydatid Disease in the Fourteen Years 1868 *to* 1881, *inclusive, in Victoria.*

Year.	Age not stated.	Below ten years old.	Ten to twenty.	Twenty to thirty	Thirty to forty.	Forty to fifty.	Fifty to sixty.	Over sixty yrs. old.	Annual totals.
1868	—	3	3	7	9	8	3	0	33
1869	—	1	4	2	7	6	2	0	22
1870	—	2	1	5	3	3	2	1	17
1871	—	2	1	2	2	4	4	0	15
1872	—	2	5	2	10	7	1	2	29
1873	—	2	4	7	3	5	6	2	29
1874	—	2	6	3	14	8	6	2	41
1875	—	4	6	10	10	7	8	2	47
1876	—	3	2	4	7	11	5	4	36
1877	3	2	5	8	5	7	5	3	38
1878	—	3	4	12	2	11	2	3	37
1879	—	2	7	8	13	11	12	7	60
1880	1	5	6	10	7	8	8	3	48
1881	—	3	3	9	8	13	9	3	48
	4	36	57	89	100	109	73	32	500

The proportion in which the different organs and tissues of the body were attacked varied greatly, as will be seen by reference to the annexed table.

Table of Deaths Returned as being due to Hydatid Disease in Victoria during the Years 1868 *to* 1881, *inclusive.*

Year.	Liver.	Lungs and Pleura.	Brain and Spinal Cord.	Heart and Pericardium.	Kidney.	Spleen.	Pancreas.	Omentum.	Ovary.	Womb (?)	"Abdominal Cavity."	Situation not Recorded.	More than One Organ Invaded.	Other Situations.	Total Annual Deaths.
1868	17	5	0	1	0	0	0	0	0	0	2	7	1 *(a)*	0	33
1869	6	8	1	0	0	0	1	0	0	0	2	1	3 *(b)*	0	22
1870	10	2	1	0	0	0	0	0	0	0	0	4	0	0	17
1871	4	6	1	0	0	1	0	0	0	1	0	1	1 *(c)*	0	15
1872	19	3	1	1	0	0	0	0	0	0	2	2	1 *(d)*	0	29
1873	17	3	2	0	0	0	0	0	0	0	0	2	5 *(e)*	0	29
1874	21	10	1	0	0	0	1	0	0	0	0	6	2 *(f)*	0	41
1875	29	7	0	2	0	1	0	0	1	0	3	2	2 *(g)*	0	47
1876	23	1	0	0	2	0	0	0	0	0	1	4	5 *(h)*	0	36
1877	20	8	0	1	0	1	0	1	0	0	3	2	2 *(i)*	0	38
1878	23	2	0 *(k)*	0	0	0	0	0	0	1	3	2	5 *(k)*	1 *(l)*	37
1879	31	12	1	0	0	0	0	0	0	1	7	6	1 *(n)*	1 *(m)*	60
1880	26	10	0	2	0	0	0	0	1	0	2	6	1 *(o)*	0	48
1881	25	8	1	1	0	0	0	0	0	0	4	7	1 *(q)*	1 *(p)*	48
Totals	271	85	9	8	2	3	3	1	2	3	29	52	30	3	500

(a). Lungs and Kidneys.
(b). In two instances Liver and Lungs; in the third case, Liver and Brain.
(c). Lungs and Liver.
(d). Lungs and Abdominal Cavity.
(e). In three cases, Liver and Lungs; in one, Kidney and Abdomen; in another, Liver, Lungs, Omentum.
(f). Liver and Lungs.
(g). One Liver and Lungs; the second case, Lungs and Heart.
(h). Three cases Liver and Lungs; one Liver and Kidney.
(i). Liver and Lungs.
(k). Including three Lungs and Liver, one Lungs and Brain, and one Brain and Liver.
(l). Of Penis with Cystitis.
(m). Of Bladder.
(n). Lungs and Heart.
(o). Lungs and Liver.
(p). Bladder.
(q). Lungs and Abdomen.

X

As might have been expected, a considerable proportion occurred in the various hospitals of the colony; in fact during the ten years 1872-1881, inclusive, more than one-third of the total deaths from Hydatids occurred in hospital patients. The details appear in the subjoined table, courteously supplied to the writer by Mr. Hayter.

Return showing the Number of Deaths from Hydatid Disease in Victoria, during the Ten Years 1872 *to* 1881, *distinguishing the Number which Occurred in Hospitals.*

Year.	Deaths from Hydatid Disease.		
	In Hospitals.	Outside Hospitals.	Total.
1872	11	18	29
1873	16	13	29
1874	10	31	41
1875	23	24	47
1876	12	24	36
1877	14	23	37
1878	12	25	37
1879	20	40	60
1880	7	41	48
1881	22	26	48
In ten years ..	147	265	412

We now come to the second source of information, viz.—

THE HOSPITAL RETURNS.

Cases of Hydatid Disease Treated in the Hospitals of Victoria.

Hospital.	Number of Patients.			Results of Treatment.					Remarks.
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.	
Alexandra	2	—	2	1	—	—	1	—	
Alfred	13	24	37	—	—	—	8	29	
Ballarat	—	—	125	—	84	13	28	—	Sex not given.
Beechworth ..	31	26	57	23	18	—	16	—	
Belfast	—	—	—	—	—	—	—	—	No cases treated.
Castlemaine ..	1	8	9	3	5	—	1	—	
Clunes	7	4	11	4	2	1	4	—	
Creswick	8	7	15	6	4	—	5	—	
Daylesford ..	2	—	2	—	1	—	1	—	
Dunolly......	8	6	14	9	2	—	3	—	

Cases of Hydatid Disease Treated, &c.—continued.

Hospital.	Number of Patients.			Results of Treatment.					Remarks.
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.	
Geelong.... .	40	25	65	11	29	6	10	9	
Heathcote....	6	1	7	4	2	—	1	—	
Horsham	6	1	7	2	2	1	2	—	
Inglewood....	6	2	8	4	3	—	1	—	
Kilmore......	3	—	3	1	—	2	—	—	
Kyneton	13	4	17	7	4	—	6	—	
Maldon	—	—	—	—	—	—	—	—	No cases treated.
Mansfield	—	—	—	—	—	—	—	—	No cases treated.
Maryborough	33	14	47	29	7	—	11	—	
Melbourne ..	205	156	407*	—	—	—	72	335	*Including 46 cases in which the sex was not given.
Pleasant Creek	10	11	21	17	4	—	—	—	
Portland	—	—	—	—	—	—	—	—	No cases treated.
St. Arnaud ..	2	—	2	—	1	—	1	—	
Sale	8	3	11	9	1	—	1	—	
Sandhurst	70	44	114	68	9	7	30	—	
Swan Hill....	—	—	—	—	—	—	—	—	No cases treated.
Wangaratta ..	3	—	3	1	—	—	2	—	
Warrnambool	—	—	—	—	—	—	—	—	No cases treated.
Wood's Point	16	1	17	8	7	—	2	—	
	498	337	1001†	207	185	30	206	373	†Including Melbourne, 46; Ballarat, 125; total 171, sex not given.

In the following hospitals no cases of Hydatid disease had been treated up to the date when their returns were furnished:—Belfast, Maldon, Mansfield, Portland, Swan Hill, and Warrnambool.

Mortality.—Out of 1,001 cases under treatment, the result was not mentioned in 373 cases, leaving 628 cases, with 206 deaths = 32·8 per cent.

Sex.—There was a considerable preponderance of males, thus—

Males	493
Females	337
	830
Sex not mentioned	171
Total number of cases treated	1,001

Proportion in which the Various Organs of the Body were Affected.

CLASS A.—SINGLE CYSTS.

Organs	Males.	Females.	Totals.	Remarks.
Liver	147	93	304	Including 64 cases treated in Ballarat Hospital, in which the sex was not given.
Lungs	54	23	83	Including 6 cases treated in Ballarat Hospital, in which the sex was not given.
Omentum..............	6	6	12	
Brain	5	—	5	
Uterus	—	4	4	
Ovary	—	3	3	
Muscles	3	1	4	
Sub-cutaneous tissue	3	3	6	
Breast (female)	—	2	2	
Heart	2	—	2	
Spleen	2	1	3	
Kidney................	2	—	2	
"Elsewhere in abdominal cavity"..............	16	8	24	
Other places, situation not mentioned	230	185	516	Including Ballarat 55 cases, and Melbourne 46 cases, in which the sex was not given.
Totals	470	329	970	Including 171 cases, in which sex was not given.

CLASS B.—MULTIPLE CYSTS.

Situation.	Number of Patients.			Results of Treatment.					Remarks.
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.	
Liver only	3	3	6	1	2	—	3	—	
Liver and lung	7	2	9	3	—	—	6	—	
Liver, lung, & omentum	1	—	1	—	—	—	1	—	
Liver and kidney	3	—	3	—	—	—	3	—	
Liver, spleen, bladder, and mesentery	1	—	1	—	—	—	1	—	
Liver and "elsewhere in abdomen"	4	—	4	—	1	1	2	—	
Liver, omentum, and testis	1	—	1	—	—	—	1	—	
Lung only	1	1	2	1	1	—	—	—	

CLASS B.—MULTIPLE CYSTS—*continued.*

Situation.	Number of Patients.			Results of Treatment.					Remarks.
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.	
Lungs, heart, and spleen	1	—	1	—	1	—	—	—	Died subsequently in Melbourne Hospital.
Lungs and pericardium	—	1	1	—	—	—	1	—	
	22	7	29	5	5	1	18	—	
GRAND TOTAL—									
Single cysts	471	330	972	202	180	29	188	373	
Multiple	22	7	29	5	5	1	18	—	
Total of organs	493	337	1001*	207	185	30	206	373	* Sex not known in 171 cases.

Mortality.—As might have been expected, all the cases of heart and brain cysts were fatal. Curiously enough these occurred in men only. There were four cases in which the uterus was said to have been attacked, but as recovery took place in three out of the four cases, and as there is no record of a *post-mortem* examination having been made in the fatal one, it must be doubtful whether the disease referred to was Echinococcus cyst, or merely Hydatid mole.

With regard to the ovary, three cases are mentioned, but as only one of these cases was fatal, there must necessarily be some doubt as to the exact seat of the cyst. In one case, however, which occurred at the Sandhurst Hospital, death took place, and an autopsy was made, which showed that the cyst was truly ovarian, and that there was no other Hydatid present in the body.

The mortality of liver cases whilst in the hospitals was 17·65 per cent.; that of lung cases was very much higher, viz., 26·50 per cent.

In the cases of Multiple cysts, there was a high rate of mortality, viz., 18 out of 22 persons attacked.

The mortality of Hydatid disease, taken in the gross, was 32·8 per cent.

As regards the different hospitals, it is important and interesting to note that they did not receive cases of this disease in like ratio to their general In-patients. This is shown by the table appended.

Proportion of Hydatids in the various Hospitals of Victoria.

Hospital.	Period over which the Returns Extend.	Hydatids.	Total Number of In-patients.	One Hydatid to
Alexandra	1876 to 1879 inc.	2	124	62·
*Alfred	1871 " 1878 "	37	5,154	139·29
Ballarat	1867 " 1879 "	125	13,152	105·21
Beechworth	1864 " 1879 "	57	8,046	141·05
Belfast..........	Date of opening " 1879 "	—†	643	—
Castlemaine	1870 to 1879 "	9	7,603	844·77
Clunes..........	1871 " 1879 "	11	1,560	141·81
Creswick........	1864 " 1879 "	15	3,655	243·66
Daylesford	1873 " 1879 "	2	1,195	597·50
Dunolly	1874 " 1879 "	14	1,878	134·15
Geelong	1870 " 1879 "	65	8,388	129·04
Heathcote	1860 " 1879 "	7	1,789	255·57
Horsham........	1875 " 1879 "	7	952	136·00
Inglewood	1863 " 1879 "	8	3,912	489·
Kilmore	1860 " 1879 "	3	2,262	754·00
Kyneton	1870 " 1879 "	17	3,230	190·
Maldon	1870 " 1879 "	—†	610	—
Mansfield	1869 " 1879 "	—†	561	—
Maryborough	— 1869 "	27	—	—
	1870 " 1879 "	20	4,391	219·55
Melbourne	1860 " 1879 "	407	71,232	175·01
Pleasant Creek ..	1859 " 1879 "	21	6,471	308·14
Portland	1857 " 1879 "	—†	503	—
St. Arnaud	Dec. 1874 " 1879 "	2	803	401·50
Sale	1868 " 1879 "	11	1,962	178·36
Sandhurst	1867 " 1879 "	114	14,058	123·31
Swan Hill	Date of opening " 1879 "	—†	2,434	—
Wangaratta	July 1876 " 1879 "	3	807	269·00
Warrnambool	Aug. 4, 1864 " 1879 "	—†	888	—
Wood's Point	1866 " 1879 "	17	1,375	80·88
		1,001		
		Less 27‡		
		974	169,638	=174·16

Taking the hospitals of Victoria as a whole, we find that about one out of every 175 of all the cases admitted as In-patients was a case of Hydatid disease.

In the following hospitals, during the period over which their returns extended, there were said to have been no cases of Hydatid diseases treated :—Belfast, Mansfield, Swan Hill, Maldon, Portland, Warrnambool. The highest proportion of cases was found in the

* No returns tabulated for 1876-77.

† There were no cases of Hydatids recorded in these hospitals.

‡ Deducted on account of cases in Maryborough Hospital prior to 1869, because the number of total In-patients treated in that period is not recorded.

Alexandra, Wood's Point, Horsham, and Sandhurst Hospitals, but as the three first-named hospitals had only a small number of In-patients under treatment, but little weight can be attached to their apparently high proportion of Hydatids. The case, however, is different as regards Sandhurst, where, during the twenty-two years over which the returns extend, there were treated as In-patients 14,058 persons, including 114 cases of Hydatid disease, being at the rate of about 1 to every 123.

In order to obtain a fair estimate, all hospitals receiving but few patients should be excluded from the comparison, as has been done in the next table.

Percentage of Hydatid Cases in the following Hospitals, none of which returned less than 5,000 In-patients during the period included in the returns.

Hospital.	Total Hydatid Cases.	Total In-patients.	Percentage of Hydatids.
Castlemaine	9	7,603	·0118
Pleasant Creek	21	6,471	·0324
Melbourne	407	71,232	·0571
Beechworth	57	8,046	·0708
Alfred (Melbourne)	37	5,154	·0717
Geelong	65	8,388	·0774
Sandhurst	114	14,058	·0810
Ballarat	125	13,152	·0950
Totals	835	134,104	·0622

Summary.—In the above-mentioned hospitals the average percentage of Hydatid cases was ·0622.

NEW SOUTH WALES.

According to Hayter, the population of the colony on December 31st, 1881, was 781,265 persons. The mean annual mortality for the eleven years 1869-79, inclusive, was 14·96 per 1,000.

The Under-Secretary writing under date Sydney, April 11th, 1878, reports that "No separate classification of Hydatid disease "was made before the year 1875."

By the favor of the Government, the writer was supplied with

the annual returns of the deaths due to Echinococcus from 1875 to 1881, inclusive; they appear in the table appended.

Table showing the Number of Persons of each Sex that Die l in New South Wales from Hydatid Disease in the Seven Years 1875 *to* 1881, *inclusive.*

Year.	Deaths from Hydatids.			Total Deaths from all Causes.
	Males.	Females.	Total.	
1875	3	1	4	10,771
1876	3	8	11	11,193
1877	7	5	12	9,869
1878	4	5	9	10,763
1879	2	2	4	10,200
1880	1	2	3	11,231
1881	9	4	13	11,536
In 7 years	29	27	56	75,563

Thus, during the period in question, Echinococcus caused one out of every 1349·3 deaths, or at the rate of ·741 per 1,000.

When we compare the returns for this colony with those for Victoria, three important points strike us:—

1st. The smaller proportion of deaths due to this cause in New South Wales. Thus:—

In Victoria (1868 to 1880) .... 2·98 per 1,000 deaths were due to Hydatids.
In New South Wales (1875 to 1882) 0·741 " " "

2nd. In New South Wales the number of deaths from this cause was practically equal in the two sexes, whilst in Victoria there was a large preponderance of cases in males.

3rd. As far as the returns go, they show no increased frequency of the disease in New South Wales during late years; thus in the first three years there were twenty-seven deaths returned as caused by Echinococcus; in the last three years only twenty were so returned.

Ages of Patients.—Here as elsewhere no age was exempt, as will be seen in the next table.

Table showing the Ages of the Persons who Died of Hydatid Disease in the Colony of New South Wales, during the Seven Years 1875 *to* 1881, *inclusive.*

Year.	Under ten yrs. of age.	Ten to twenty years old.	Twenty to thirty.	Thirty to forty.	Forty to fifty.	Fifty to sixty.	Over sixty years old.	Annual total.
1875	—	1	2	1	—	—	—	4
1876	2	1	—	4	2	1	1	11
1877	1	2	3	2	2	1	1	12
1878	1	—	4	1	3	—	—	9
1879	1	—	1	1	1	—	—	4
1880	1	1	—	1	—	—	—	3
1881	—	2	—	2	6	2	1	13
	6	7	10	12	14	4	3	56

The situation of the cysts was not mentioned in the returns.

The Hospital Statistics of Hydatid Disease in New South Wales.—Returns were received from the following institutions :—Albury, Armidale, Bathurst, Braidwood, Carcoar, Cooma, Deniliquin, Dubbo, Grafton, Gulgong, Gundagai, Hay, Hill End, Maitland, Mudgee, Murrurundi, Muswellbrook, Narrabri, Newcastle, Parkes, Parramatta, St. Vincent's Hospital (Sydney), Scone, Singleton, Sofala, the Sydney Infirmary, Tamworth, Wellington, Yass, and the Young Hospitals.

As regards the Bathurst Hospital, the secretary (Mr. Samuel Andrews) reports that "The Bathurst Hospital was destroyed by "fire in 1878, and the records were then lost," so that no returns could be supplied bearing upon the subject in question.

In the eleven following hospitals, no cases of this disease were recorded :—Carcoar, Gulgong, Hay, Hill End, Mudgee, Muswellbrook, Narrabri, Parkes, Singleton, Sofala, Yass.

The table appended shows, as far as the records go, the number of Hydatid and other cases treated as In-patients at the various hospitals.

Table showing the Proportion of Cases of Hydatid Disease treated in the Hospitals of New South Wales.

Name of Hospital.	Period over which the Returns Extend.	Number of Cases of Hydatids.	Total In-patients Treated during the same period.	One Case of Hydatid to Total In-patients.
Albury	1869-79, inclusive	13	1,632	125·54
Armidale	1875-79, inclusive	2	482	241·
Bathurst *(a)*....	no record	—	—	—
Braidwood *(b)*..	1869 to 1879, inclusive	8	395	49·37
Carcoar	1870 to 1879, inclusive	—	575	—
Cooma	1867 to 1879, inclusive	1	286	286·
Deniliquin	1856 to 1879, inclusive	4	2,257	564·25
Dubbo	from foundation to 1879, inclusive	2	No return	—
Forbes	1878 to 1881, inclusive	6	No return	—
Grafton	1864 to 1879, inclusive	—	1,034	—
Gulgong	1871 to 1879, inclusive	—	626	—
Gundagai	1869 to 1879, inclusive	1	464	464·
Hay	1877 to 1879, inclusive	—	400	—
Hill End	no record	—	No return	—
Maitland	1878 to 1879, inclusive	4	195	48·75
Mudgee	1870 to 1879, inclusive	—	1,106	—
Murrurundi	1874 to 1879, inclusive	1	429	429·
Muswellbrook ..	from foundation to 1880, inclusive	—	712	—
Narrabri	from foundation to 1879, inclusive	—	647	—
Newcastle	1878 to 1880, inclusive	1	688	688·
Parkes	1877 to 1879, inclusive	—	120	—
Parramatta	no record	1	No return	—
Scone *(c)*	1869 to 1879, inclusive	—	194	—
Singleton	over thirty years	—	No return	—
Sofala *(d)*......	1870 to 1879, inclusive	—	69	—
Sydney Infirmary	1873 to 1879, inclusive	32	16,281	508·78
St. Vincent's "	1874 to 1879, inclusive	11	2,073	188·45
Wellington *(e)*..	one year	—	No return	—
Tamworth......	1857 to 1879, inclusive	15	2,369	157·93
Yass	1872 to 1879, inclusive	—	1,576	—
Young	1862 to 1879, inclusive	1	1,150	1,150·
		103	35,760	—

(a) The Bathurst Hospital was destroyed by fire in December, 1878, and its past records were then lost.

(b) The Medical Officer of the Braidwood Hospital reported that, although there had been but few cases of Hydatid disease treated in the hospital, "yet, in his private practice in the district, he has "had many (fully twenty) such cases under his care."

(c) Dr. Creed, of Scone, had met with six cases of Hydatid disease in private practice within his district.

(d) Dr. Hinton, the Medical Officer, reports "that there is no female ward attached to the institu- "tion, that the chief cases treated result from mining accidents, and that for the past ten years not a "single case of Hydatid disease has been treated in the institution."

(e) The Medical Officer states that, although no case of Hydatids had been admitted into the Wellington Hospital during the twelve months prior to November 23rd, 1880, yet that cases of this kind occasionally occur in the district.

From the table it will be seen that 103 cases of Hydatid disease were under treatment in the various hospitals of New South Wales during the period over which their returns extended.

In the case of six of the hospitals, it is unknown what the total number of In-patients treated was. The hospitals in question were those at Dubbo, Forbes, Hill End, Parramatta, Singleton, and Wellington.

From twenty-four hospitals this information was obtained, and the following is the result—

Out of a total of 35,760 In-patients, there were ninety-four cases of Hydatid disease, being at the rate of one out of every 380·42 In-patients.

Table showing the Proportion in which the Various Organs of the Body were Affected by Hydatids, in the Hospitals of New South Wales.

CLASS A.—SINGLE CYSTS.

Organ Invaded.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver	31	22	54*	20	14	1	15	4
Kidney	1	—	1	—	1	—	—	—
Lung	4	2	8†	5	1	—	2	—
Spleen	—	2	2	—	—	—	2	—
Omentum	1	—	1	1	—	—	—	—
Prostate gland	1	—	1	1	—	—	—	—
"Elsewhere in abdominal cavity"	3	1	4	1	1	—	2	—
Heart	1	—	2‡	—	—	—	2	—
Muscles	1	1	2	2	—	—	—	—
Diaphragm	1	—	1	1	—	—	—	—
Brain	—	2	2	—	—	—	2	—
Spinal cord	1	—	1	—	—	—	1	—
Ovary	—	4	4	—	—	—	4	—
Bones	—	2	2	1	1	—	—	—
Sub-scapular	1	—	1	1	—	—	—	—
Over deltoid	—	—	1‖	1	—	—	—	—
Pleura	—	1	1	1	—	—	—	—
Situation not mentioned	—	—	1§	—	—	—	—	1
	46	37	89	35	18	1	30	5

* Including one case treated at Forbes Hospital, in which the sex was not mentioned.
† Including two cases at the Forbes Hospital, sex not given.
‡ Including one case Forbes Hospital, sex not given.
‖ In Forbes Hospital, sex not mentioned. § In Cooma Hospital, sex not mentioned.

Table showing the Proportions in which the Various Organs, &c.—continued.

CLASS B.—MULTIPLE CYSTS.

Organ Invaded.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver only............	6	1	7	1	3	—	3	—
Liver and elsewhere in abdominal cavity ..	2	2	4	—	2	—	1	1
abdominal cavity	—	—	1*	—	—	—	—	1
Liver and lung	1	1	2	—	—	—	2	—
	9	4	14	1	5	—	6	2

QUEENSLAND.

According to Hayter, the population of this colony on December 31st, 1881, was 226,968.

The mean annual death-rate for the sixteen years 1865-1880, inclusive, was 17·86 per 1,000 of the mean population.

Hydatid Disease.—From the published returns it appears that no particulars were supplied as to the deaths from this cause prior to the year 1878, but the subjoined table shows the data given for the four years immediately succeeding:—

Table showing the Number of Persons of each Sex that were reported to have Died from Hydatid Disease in the Years 1878-81, *inclusive.*

Year.	Males.	Females.	Total.	Percentage of Annual Mortality due to Hydatid Disease.
1878	—	2	2	·05
1879	—	—	—	—
1880	1	—	1	·03
1881	—	2	2	·06
Totals for four years....	1	4	5	

From this it is evident that cases of this disease are comparatively rare in Queensland. Sex of persons attacked:—

Male	1
Female	4
	5

* Sex not given.

Organs Invaded.

Liver	2 cases
Lungs and pleura	1 "
Situation not stated	2 "
	5 "

Ages of Deceased Persons.

Age.	Number of Cases.
Under 10 years of age	2
10 to 20	—
20 to 30	—
30 to 40	—
40 to 50	2
50 to 60	1
Above 60	—
Total	5

Hydatid Disease in the Hospitals of Queensland.—Returns were received from the following hospitals:—Brisbane, Bowen, Charters Towers, Cooktown, Georgetown, Ipswich, Maryborough, Springsure, Stanthorpe, and Toowoomba.

Cases of Hydatid Disease Treated in Queensland Hospitals.

Hospital.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Brisbane	4	5*	9	6	3	—	—	—
Bowen	—	—	—	—	—	—	—	—
Charters Towers	—	—	—	—	—	—	—	—
Cooktown	—	—	—	—	—	—	—	—
Georgetown	—	—	—	—	—	—	—	—
Ipswich	1	1	2	1	—	1	—	—
Maryborough	—	—	—	—	—	—	—	—
Springsure	—	—	—	—	—	—	—	—
Stanthorpe	2	2†	4	1	—	—	3	—
Toowoomba	1	—	1	1	—	—	—	—
	8	8	16	9	3	1	3	—

* Two said to be situated in the ovary. Cured. † One of these was not a hospital patient.

Organs Affected.

CLASS A.—SINGLE CYSTS.

Organ.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver	3	—	3	1	—	—	2	—
Uterus	—	1	1*	1	—	—	—	—
Ovary	—	3	3	2	—	—	1†	—
Muscles	1	—	1	—	1	—	—	—
	4	4	8	4	1	—	3	—

CLASS B.—MULTIPLE CYSTS.

Situation.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
In liver only	3	2	5	4	1	—	—	—
In liver and elsewhere in the abdomen	1	1	2	1	—	1	—	—
In lungs alone	—	1	1	—	1	—	—	—
	4	4	8	5	2	1	—	—

The hospital returns were not sufficiently complete to enable any exact estimate of the relative frequency of Hydatid cases to be made, but both these and the mortality returns of the Registrar-General testify to the comparative rarity of Echinococcus disease in Queensland.

SOUTH AUSTRALIA.

According to the census taken in April, 1881, the total population amounted to 279,865 souls; of these there were—

Males	149,530
Females	130,335
	279,865

* This may have been a case of Hydatid Mole.—J. D. T. † This was not a hospital patient.

The mean death-rate per annum for the sixteen years 1865-1880, inclusive, was, according to Hayter, 15·16 per 1,000.

The writer is indebted to the courtesy of J. F. Cleland, Esq., the Registrar-General of the province, for the data in the subjoined table.

Table showing the Number of Persons of each Sex that Died in South Australia from Hydatid Disease in the Seventeen Years 1866 *to* 1882, *inclusive.*

Year.	Males.	Females.	Totals.	Proportion of Total Mortality due to Hydatid Disease.
1866	—	—	—	
1867	—	—	—	
1868	—	—	—	
1869	—	—	—	
1870	—	—	—	
1871	—	1	1	
1872	—	—	—	
1873	1	2	3	
1874	—	1	1	
1875	1	1	2	
1876, 1877	8	3	11	1·61 per 1,000
1878, 1879	1	2	3	
1880, 1881	9	4	13	1·61 "
1882	7	5	12	2·73 "
	27	19	46	

Table showing, arranged in Decades, the Ages of the Persons that Died of Hydatid Disease in South Australia during the Seventeen Years 1866 *to* 1882, *inclusive.*

Year.	Under ten years of age.	Ten to twenty.	Twenty to thirty.	Thirty to forty.	Forty to fifty.	Fifty to sixty.	Over sixty years old.	Total.
1866-67-68-69-70	—	—	—	—	—	—	—	0
1871	—	—	—	1	—	—	—	1
1872	—	—	—	—	—	—	—	0
1873	—	—	—	3	—	—	—	3
1874	—	—	1	—	—	—	—	1
1875	—	—	—	1	—	1	—	2
1876-77	3	1	4	2	—	1	—	11
1878-79	—	—	3	—	—	—	—	3
1880-81	1	—	2	4	4	1	1	13
1882	—	2	2	1	4	1	2	12
	4	3	12	12	8	4	3	46

Hydatid Disease in the Hospitals of South Australia.—The only hospitals of sufficient size to be of importance in this respect are the Adelaide and Mount Gambier institutions.

In the subjoined tables the records of the former are shown for thirty-one years, and of the latter during fourteen years.

The Adelaide Hospital receives its inmates from all parts of the colony; that at Mount Gambier principally from the south-eastern district of the province.

THE ADELAIDE HOSPITAL.

Number of Cases of Hydatid Disease under Treatment during the Years 1852 *to* 1882, *inclusive.*

Situation or Organ.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver	61	48	109	35	46	3	12	13
Peritoneum	1	—	1	—	—	—	1	—
Liver and abdomen	1	—	1	1	—	—	—	—
"Elsewhere in the abdominal cavity"	1	1	2	1	—	—	1	—
Kidney..........	1	—	1	1	—	—	—	—
Lung	20	6	26	8	16	—	—	2
Thorax	—	1	1	—	1	—	—	—
Brain	1	—	1	—	—	—	1	—
Neck	2	—	2	1	—	—	—	1
Cheek	—	1	1	—	1	—	—	—
Forehead	1	—	1	1	—	—	—	—
Muscles	1	4	5	3	1	—	1	—
Locality not stated	12	11	23	10	8	1	4	—
Female breast	—	1	1	1	—	—	—	—
	102	73	175	62	73	4	20	16

During the same period there were treated, as In-patients, 38,671 persons; so that during these thirty-one years one case out of every 222·24 In-patients was Hydatid.

There has not been of late any very notable increase in the number of these cases admitted, for during the five years 1873 to 1877, inclusive, there were seventy cases admitted; from 1878 to 1882, inclusive, there were seventy-four cases admitted.

THE MOUNT GAMBIER HOSPITAL.

Number of Cases of Hydatid Disease treated from January, 1879, *to December* 31*st,* 1882, *inclusive.*

Situation or Organ.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver	17	8	25	11	7	1	5	1
Kidney	1	—	1	—	—	—	1	—
Omentum	3	2	5	—	4	—	1*	—
"Elsewhere in the abdominal cavity"	2	1	3	3	—	—	—	—
Lung	11	5	16	8	6	—	2	—
Pleura	1	—	1	—	—	1†	—	—
Neck	1	—	1	1‡	—	—	—	—
Sub-cutaneous tissue	3	1	4	3	1	—	—	—
	39	17	56	26	18	2	9	1

Of these fifty-six, two cases were re-admissions, viz., one female, aged 22, suffering from Hydatid of the liver, discharged relieved, but not expected to recover; the other, a man, aged 35, with Hydatid of the pleura, also not expected to recover.

The secretary, A. K. Varley, Esq., also reported two other cases discharged relieved, which afterwards died outside the hospital.

Taking the entire record of this hospital from 1879 to 1882, inclusive, in round numbers about one out of every sixty-two In-patients had Hydatid disease.

During the last ten years the proportion has been higher, viz., about one out of fifty-five In-patients, but the numbers for the last five years have not exceeded those for the preceding five years.

With one exception, all the cases came from the south-eastern district, and nearly all from swampy country.

It cannot fail to attract the notice of the reader that the Mount Gambier Hospital records show a very high proportion of cases of Echinococcus disease. Indeed, next to Iceland, no part of the world shows so serious a prevalence of the disease as the south-eastern district of South Australia, whence the Mount Gambier Hospital receives most of its patients. The matter is further discussed in a later part of this work.

* Probably multiple cysts. † In hospital, very ill (February, 1883).

‡ A very interesting account of this case was published by Dr. Jackson, *Australian Medical Journal,* June, 1871.

NEW ZEALAND.

According to Hayter's Year-Book, 1882, the population of this colony, on December 31st, 1881, was 500,910.

The mean annual death-rate during the sixteen years 1865 to 1880 was 12·38 per 1,000.

Hydatid Disease.—The returns of the causes of death were not compiled by the Registrar-General's Department prior to the year 1873.

The earliest return supplied to the writer was that for the year 1877, and in this there is no reference made to Hydatid disease, although five deaths are attributed to "worms" in the boroughs of Auckland, Thames, Wellington, Nelson, Christchurch, Dunedin, and Hokitika. The returns for subsequent years, however, are more complete, and they extend up to the year 1882.

Table showing the Number of Persons of each Sex that Died in New Zealand from Hydatid Disease, in the Four Years 1878-81, *inclusive.*

Year.	Males.	Females.	Totals.	Percentage of Mortality due to Hydatid Disease.
1878........................	2	4	6	·129
1879........................	4	3	7	·125
1880........................	3	6	9	·165
1881........................	—	3	3	·055
	9	16	25	

The average of the four years shows that ·116 per cent. of the total mortality of New Zealand was due to Hydatid disease.

Sex.—Nine of the deaths were those of males, whilst sixteen of the deaths were those of females.

Table showing the Proportion in which the Various Organs of the Body were Attacked.

Organ.	Number of Cases.	Remarks.
Liver..............	17	Three cases liver and lungs, one liver and spleen; one death took place from strangulation of the bowels.
Lungs and pleura....	1	
Brain and spinal cord	2	
Bones of pelvis......	1	
Situation not recorded	4	In one case ovarian cystic disease was also present.
Total......	25	

Ages of Deceased Persons.

Age.	Number of Persons.
1 to 10 years old	None.
10 " 20 "	1
20 " 30 "	6
30 " 40 "	9
40 " 50 "	5
50 " 60 "	4
Above 60 "	None.
	25

Hydatid Disease in the Hospitals of New Zealand.—By the courtesy of the Government, returns were obtained from the following hospitals:—Auckland, Charlestown, Christchurch, Dunedin, Gisborne, Hokitika, Invercargill, Lawrence, Napier, Naseby, Nelson, New Plymouth, Oamaru, Picton, Reefton, Ross, Thames, Timaru, Wakatipa, Wellington, and Westport.

In the following institutions there were no cases of Hydatid disease:—Charlestown, Gisborne, Invercargill, Lawrence, Napier, Naseby, Oamaru, Picton, Reefton, Thames, and Timaru.

The data procured from the remaining hospitals appear in the following tables:—

Cases of Hydatid Disease treated in the Hospitals of the Colony of New Zealand.

Hospital.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Auckland	—	—	1*	—	—	—	1	—
Christchurch	—	—	1*	—	—	—	—	1
Dunedin	11	6	17	3	5	—	7	2
Hokitika	2	1	3	—	1	—	2	—
Nelson	1	1	2	2	—	—	—	—
New Plymouth	7	13	20	1	9	6	2	2
Wakatipa	1	5	6	5	—	—	1	—
Wellington	3	1	4	1	1	—	2	—
Westport	3	—	3	2	—	—	1	—
Totals	28	27	57	14	16	6	16	5

* Sex not mentioned.

Sex.—In two instances the sex was not given, of the remainder there were—

Males	28
Females	27

The proportion of the sexes admitted into the above-named hospitals was about one female to three males, consequently there is a disproportionately large number of females attacked in this province.

Taking the entire hospital population, it is impossible for the writer to give any exact information illustrative of the proportion of hydatid cases, inasmuch as in many instances he has been unable to ascertain the total number of In-patients treated. It is certain, however, that the number of cases of Hydatids must be exceedingly small. As far as the data go, they are as follows:—

Hospital.	Number of Cases of Hydatids Treated.	Total Number of In-patients under Treatment during the same period.
Auckland	1	10,783
Charleston	—	505
Dunedin	17	13,288
Hokitika	3	2,339
Naseby	—	440
New Plymouth	20	3,054
Oamaru	—	736
Reefton	—	353
Timaru	—	3,185
Wakatipa	6	825
Wellington	4	about 4,000
Westport	3	763
	54	40,271

This is at the rate of 1 out of 745·7 total In-patients.

Proportion in which the various Organs of the Body were Invaded.

CLASS A.—SINGLE CYSTS.

Organ Attacked.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver	13	6	21*	5	7	1	4	4
Lung	1	—	1	—	—	—	1	—
Subcutaneous tissue	—	4	4	4	—	—	—	—
Uterus	—	4	4	1	—	2	—	1
Ovary	—	1	1	—	1	—	—	—

* Including two cases in which the sex was not mentioned.

CLASS A.—SINGLE CYSTS—*continued.*

Hospital.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Spleen	—	1	1	—	—	1	—	—
Kidney	1	2	3	1	—	—	2	—
Omentum	—	1	1	—	1	—	—	—
"Elsewhere in abdominal cavity"	—	1	1	—	1	—	—	—
Brain	1	—	1	—	—	—	1	—
Spinal cord	1	—	1	—	—	—	1	—
	17	20	39†	11	10	4	9	5

CLASS B. MULTIPLE CYSTS.

Organs Attacked.	Number of Patients.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Liver only	5	1	6	1	2	—	3	—
In liver and lung	4	1	5	1	2	—	2	—
Liver and elsewhere in the abdomen	2	5	7	1	2	2	2	—
	11	7	18	3	6	2	7	—

Summary.

	Number of Cases.			Results of Treatment.				
	Males.	Females.	Total.	Cured.	Relieved.	Not Relieved.	Died.	No Record.
Class A.—Single Cysts	17	20	39†	11	10	4	9	5
Class B.—Multiple Cysts	11	7	18	3	6	2	7	—
	28	27	57	14	16	6	16	5

Mortality of Hydatid Disease in New Zealand.—In five cases the result was not recorded, in sixteen death occurred in hospital, *i.e.*, at the rate of 30·7 per cent.

† Including two cases—sex not given.

TASMANIA.

According to Hayter's Year-Book, 1881-82, the population of this colony on December 31st, 1881, amounted to 118,923 souls.

The average annual death-rate for the sixteen years 1865-1880, inclusive, was 15·25 per 1,000.

Hydatid Disease.—The Colonial Secretary, writing under date Hobart Town, March 7th, 1878, reported, upon the authority of the Registrar of Births, Deaths, and Marriages, that "No "deaths from this disease were registered in the years mentioned "in the forms," and, he added, that the Government Statistician and Dr. Edward Swarbeck Hall, who had taken much interest in vital statistics, had nothing to add to the minute of the Registrar when referred to them.

The returns for the following four years are shown in the tables appended.

Table showing the Number of Deaths registered as Due to Hydatid Disease in Tasmania during the Years 1878, 1879, 1880, *and* 1881.

Year.	Males.	Females.	Totals.	Proportion of total Mortality due to Hydatid Disease.
1878	2	—	2	·1176 per cent.
1879	1	1	2	·1185 per cent.
1880	1	—	1	·0546 per cent.
1881	—	1	1	·0577 per cent.
	4	2	6	

Table showing the Ages of the Deceased Persons.

Age.	Number of Cases.
Under 10 years old	None
Between 10 and 20 years old	None
" 20 " 30 "	1
" 30 " 40 "	None
" 40 " 50 "	1
" 50 " 60 "	None
Over 60 years old	4

The situation of the cysts was not recorded in the returns.

PART V.

CONDITIONS AFFECTING THE PREVALENCE OF ECHINOCOCCUS DISEASE IN DIFFERENT COUNTRIES AND LOCALITIES.

PART V.—CONDITIONS AFFECTING THE PREVALENCE OF ECHINOCOCCUS DISEASE IN DIFFERENT COUNTRIES AND LOCALITIES.

Conditions Affecting the Prevalence of Hydatid Disease in Different Countries and Localities.—From the foregoing statistics, it will be seen that Echinococcus disease has a very wide distribution in space. Indeed, it is known to occur with greater or less frequency in almost all countries inhabited by Europeans or their immediate descendants.

So little is known of the diseases of those savage races among which European physicians have not dwelt, that it is not surprising to find no record of this affection among the few remaining primitive races. But it seems probable that, as regards the aborigines of Australia, Echinococcus disease came to them in company with whisky and other blessings of European civilization.

At the present time, however, Hydatid disease is extremely common in the "blackfellows" of both sexes who loiter about the outskirts of settlement in the colonies of Victoria and South Australia. The writer has no personal knowledge upon this point in regard to the other colonies of Australia.

It is probable that wherever man and his faithful friend and companion—the dog—are found together, there also will be found, with greater or less frequency, Hydatid disease in the former.

Whether future investigation prove this to be the case or not, it is very evident, from the statistics recorded, that at the present day the frequency of Echinococcus infection in man and the inferior animals varies much in different countries.

In Germany, France, America, and British India the disease is comparatively rare.

It is, of course, impossible to illustrate this fact by exact figures,

but as far as the data at present available extend, the results of the inquiry may be summarised as follows:—

Table showing what Proportion of the Total Mortality was referred to Hydatid Disease in Various Countries, from data supplied by their respective Registrars-General.

Country.	Period over which the Returns extend.	Proportion of Total Mortality referred to Hydatid Disease.
England and Wales....	10 years, viz., 1871 to 1881	One out of (about) 12,000 deaths
Victoria...............	14 " 1868 to 1882	2·98 per 1,000
New South Wales	7 " 1875 "	·741 "
Queensland	4 " 1878 "	Returns inadequate
South Australia	10 " 1873 to 1883	1·23 per 1,000
New Zealand	4 " 1878 to 1882	1·18 "
Tasmania	4 " "	0·871 "

Table showing what Proportion of Hospital In-patients Suffered from Hydatid Disease.

Country.	Proportion of Hydatid Disease.
Five English hospitals	About one out of (about) 1,000 in-patients
Victorian hospitals	" " 175 "
New South Wales hospitals	" " 380 "
South Australian hospitals	" " 182 "
New Zealand hospitals	" " 746 "
Tasmanian hospitals	" " 325 "

The countries in which Echinococcus is most prevalent are Iceland and Australia.

It will be interesting and instructive to discuss, therefore, what the local conditions are which, in two such dissimilar regions, encourage the spread of Hydatid infection to so high a degree.

From what has been already stated, it may be regarded as proven, beyond all question, *that the disease known as "Hydatids" in man and the domestic Herbivora is occasioned by the development of a special Bladder-worm (Echinococcus), derived from the eggs of a small Tapeworm (Tænia Echinococcus), whose usual habitat is the upper half of the small intestine of the dog.*

The minute ova of the adult Tapeworm are conveyed by some means, most commonly by the drinking water, into the stomach of the future victim, and the contained embryos ultimately develop in its organs into Hydatids.

It has been suggested by Dr. Dougan Bird,* of Melbourne, that it is possible for the eggs of the Tapeworm to be conveyed by the respired air into the lungs, and that they may there directly develop into pulmonary Hydatids without previously entering the digestive organs. This hypothesis has already been discussed. (See p. 122.)

It may be regarded as certain that the *eggs of the Tænia* must be taken into the body in order that Hydatid infection shall occur in man, for there is not the smallest evidence that the Hydatid Cyst or Echinococcus-heads of one host can directly produce an Hydatid in another host, when swallowed by the latter; consequently the popular opinion that Hydatids occur in man by eating underdone mutton is totally unfounded upon fact, and is, moreover, in the last degree improbable.

As regards the hosts of the adult Tænia, the only animals in which, up to the present time, Tænia Echinococcus has been found are the domestic dog, the wolf (Cobbold), and the jackal (Panceri). From analogy it may be expected to be present occasionally in the Australian dingo, but, as far as the writer knows, it has not been actually found in this animal.

For all practical purposes the domestic dog, therefore, must be regarded as the direct source of Hydatid infection in man and the domestic Herbivora.

But the dog itself must, in turn, receive its infection by eating the fresh viscera of animals containing Hydatid Cysts.

It is probable that the term of sojourn of Tænia Echinococcus in the bowel of the dog is a brief one—probably, indeed, it does not usually exceed a few weeks; consequently, a dog becomes soon freed from its infection. It is likely, however, that each minute Tapeworm can in succession produce several ripe proglottides; and as, moreover, there are often thousands of the Tæniæ present at the same time in the intestine, and as each ripe joint contains hundreds of eggs, it follows that a single highly-infected dog may be the agent for setting free tens of thousands of ova.

But a dog may, by frequently eating viscera containing Hydatids, keep itself continually re-infected with Echinococcus, so that virtually it may never become clean.

* On Hydatids of the Lung. S. Dougan Bird, M.D. Melbourne, 1877. Second edition, pp. 2 and 3.

As regards the domestic Herbivora, *e.g.*, sheep, pigs, and horned cattle, the case is different, for the Cystic Hydatid has a long life in its host. How long this may be is unknown, but it probably lives for many years, slowly but continually increasing in size, and forming new Brood-capsules and Echinococcus-heads, so that a large cyst may contain myriads of Echinococci at last.

From this it results that, when a dog makes a meal of such a cyst, it breeds hundreds or thousands of Tæniæ, and this explains why, in many cases, dogs contain such vast numbers of Tænia Echinococcus.

However, even in the case of the Cystic form, death comes at last; and, if the host lives long enough, the Hydatid, like every other living thing, dies, even whilst still enclosed in the body of the host. This spontaneous death is usually due to the starvation of the parasite, in consequence of degeneration of the adventitious sac through which it derives its nourishment.

From what has been just mentioned, it follows that if Echinococcus is introduced into any new country its spread will be determined by four factors—

1st. *By the number of dogs in the country.*

2nd. *By the opportunities that exist for enabling the eggs bred in the dog to be swallowed by domestic Herbivora and Man.*

3rd. *By the number of domestic Herbivora—Sheep, oxen, pigs, &c.*

4th. *By the frequency with which dogs eat the organs of infected sheep, &c., containing living Hydatids.*

Given a country with many sheep, &c., the organs of which are often eaten raw by the dogs, if the water supply be scanty, and procured from bogs, swamps, waterholes, and dams, on the banks of which dogs may deposit the eggs, to be blown in by the winds or washed in by the rains, and there be dogs in abundance, we then have all the conditions necessary to the spread of the disease.

But if sheep, oxen, pigs, &c., are few, there will be but few Hydatids. If there are not many dogs, there cannot be very many of the Tapeworms. If the dogs never eat the organs containing Hydatids, they can never become the hosts of the Tæniæ. If the eggs are blown into a large river or lake, it would be very unlikely

that a sheep should happen to swallow the particular drop of water that contains the dangerous egg.

The same conditions that govern infection in the sheep apply also as regards man, oxen, pigs, &c.

In considering the influence of the four factors already referred to upon the prevalence of Hydatids in different countries, it will be convenient in the first place to notice—

The Number of Domestic Herbivora in Different Countries.—Under this heading we shall include sheep and horned cattle, but not pigs and goats, inasmuch as the writer is not in possession of sufficiently ample data to institute a comparison as regards the last-named animals.

Table showing the Number of Domestic Herbivora (including sheep and horned cattle) per 100 *Inhabitants in the following Countries.*

Countries.*	Per 100 Inhabitants.		
	Sheep.	Horned Cattle.	Domestic Herbivora.
Great Britain	93	29	122
France	64	30	94
Germany	55	35	90
Iceland	488	36	524
Europe as a whole	66	30	96

Table showing the Number of Domestic Herbivora (including sheep and oxen) per 100 *Inhabitants in the various Colonies of Australasia.*

Colony.†	Per 100 Inhabitants.		
	Sheep.	Horned Cattle.	Domestic Herbivora.
Victoria	1,204	149	1,353
New South Wales	4,381	348	4,729
Queensland	3,067	1,398	4,465
South Australia	2,415	114	2,529
New Zealand	2,695	119	2,814
Tasmania	1,554	110	1,664
Australian Colonies as a whole	2,402	287	2,689

* The figures for Great Britain, France, Germany, and Europe as a whole are from "The Balance-sheet of the world, 1870-80," by Michael G. Mullhall, F.S.S., London, Edward Stanford, 1881, table 27, p. 40. Those for Iceland are from Krabbe, "Recherches Helminthologiques en Danemark et en Islande," page 59.

† The figures for the separate colonies have been deduced from "The Victorian Year-Book, 1880-81." By Henry Heylyn Hayter, Government Statist of Victoria. Folding-sheet, No. 3. But those for the Australian colonies as a whole are from Mullhall, loco cit.

From the tables it will be seen that the number of domestic Herbivora in relation to the human population is more than four times as great in Iceland as in Great Britain, and that Australia has more than twenty-two times as many of these animals per 100 of population as the mother-country possesses.

But when we come to consider the number of these animals in each colony, we find that in Victoria, where, according to our statistics, Hydatid disease in man is most prevalent, the number of domestic Herbivora per 100 inhabitants is the lowest, so that it is quite plain that other important elements must be operative to cause Hydatids in man, and it proves, also, that the domestic Herbivora do not directly infect man with Echinococcus disease, but merely suffer in common with him.

The Number of Dogs in these Countries.—Unfortunately, the data of this kind at present available are very scanty, for, at best, the only records procurable are the numbers of dogs *registered* by the public authorities in different countries.

According to Krabbe,* there was in Great Britain, in the year 1855, about one registered dog to every fifty inhabitants, whilst in Iceland, at the time of his investigation, there was about one dog to every three to five inhabitants. So that there were, at his lowest computation, ten times as many dogs per head of population in Iceland as in Great Britain, and, as we have already seen, there were four times as many domestic Herbivora per head.

From this it follows, other things being equal, that an Icelander was threatened with Hydatid infection from the dogs ten times more than an Englishman, and, besides this, every Icelandic dog had four times as many chances of eating the host of a Hydatid as an English dog had.

According to Burton,† in Iceland dogs were formerly far more numerous than men, "and they were trained to keep caravan "ponies on the path; now they guard the flocks, loiter about the "farms, and keep cattle off the *tún*."

---

* Op. cit.

† Ultima Thule, or a Summer in Iceland, by Richard F. Burton. London, 1875. Vol. i. p. 171.

Neisser* gives the following table, showing the proportion of dogs to the human population in various places:—

Country.	One Dog to Inhabitants.	Town.	One Dog to Inhabitants.
France	22	Baden	49
Belgium	18	Berlin	48
England	50	Stockholm..............	36
Canton Thurgau	41	Copenhagen	68
Iceland	11		

Number of Dogs in Australia.—No information is procurable as to the probable numbers of dogs in the colonies of New South Wales, Queensland, South Australia, Western Australia, and New Zealand.

However, it is certain that the number is very great, and very far indeed in excess of the usefulness of these animals.

In the earlier days of settlement in Australia the flocks of sheep were guarded by shepherds, who naturally availed themselves largely of dogs to aid them in their work. Of late years, however, nearly all sheep stations have been fenced into suitable paddocks, and hence, to a considerable extent, the need of sheep-dogs has lessened. Still a large number of such animals exist, being kept partly from custom, and partly to help in travelling "stock" from one part of the country to another.

Sporting dogs, too, such as greyhounds and so-called "kangaroo" dogs. have largely increased of late years. Finally, the cities and towns swarm with dogs, of which a Ballarat paper wittily observes, that their "number is legion and their breed is mongrel."

How numerous such unregistered dogs are in some cities is shown by the fact that in a telegram† dated Sydney, May 2nd, 1882, it was reported that "operations for the destruction of dogs "in the city for the year have just been completed. *Thirteen* "*hundred were destroyed,* only thirteen being claimed, and thirty-"two valuable ones were turned loose again. The cost to the State "was £162 10s."

In all the cities and larger towns of South Australia and Victoria, paroxysmal efforts are made to destroy unregistered dogs, but as

* Op. cit., p. 39. † The *South Australian Register*, May 2nd, 1882.

far as the writer's personal experience goes, this is done with far greater energy in South Australia than in Victoria.

By the courtesy of the Government of Victoria, the author has been supplied with very complete returns of the dogs *registered* in that colony by the officers of five cities, five towns, forty-one boroughs, and 100 shire councils; the results appear in the table appended.

Table showing the Proportion of Registered Dogs to the Population in Victoria.

Year.	Population, according to Hayter.	Number of Dogs.	Proportion of Dogs to Population.
1872	—	32,504	—
1873	772,039	33,284	1 to every 23
1874	783,274	34,191	1 " 23
1875	791,399	36,917	1 " 21
1876	801,717	36,532	1 " 22
1877	815,494	37,097	1 " 22
1878	827,439	37,251	1 " 22
1879	840,620	37,248	1 " 22½
1880	860,067	37,495	1 " 23

The author has, however, strong reasons for suspecting that not a tithe of the dogs in Victoria are registered in conformity with the provisions of the local Act.

TASMANIA.

The Government of this colony has kindly supplied the author with returns of the number of dogs registered in the City of Hobart, Town of Launceston, eighteen municipalities, and nine police districts, for the years 1872 to 1880, both inclusive. From these returns the author has prepared the table appended:—

Year.	Population, according to Hayter.	Number of Dogs Registered.	Proportion of Dogs to Population.
1872	—	11,101	—
1873	104,217	11,248	1 to 9·26 persons
1874	104,176	11,669	1 to 8·92 "
1875	103,663	11,721	1 to 8·84 "
1876	105,414	12,497	1 to 8·44 "
1877	107,104	12,153	1 to 8·81 "
1878	109,947	12,768	1 to 8·61 "
1879	112,469	12,721	1 to 8·84 "
1880	114,762	13,318	1 to 8·61 "

It is remarkable that the dogs registered in Tasmania appear to be almost three times as numerous in proportion as in Victoria. Probably this is attributable to greater stringency in the registration of these animals in Tasmania, and does not really represent the existence of a greater proportional number of dogs in that colony.

Of course, the domestic Herbivora, and the dogs in any country, merely represent the number of hosts suitable for the development, respectively, of the Cystic Hydatid and the Cestoid Tænia Echinococcus, and the next important element to consider is, the number of these animals actually found to be infested with the parasite.

Proportion of Domestic Herbivora Infested with Echinococcus in Various Countries.—As regards Great Britain and the greater part of the continent of Europe, but little information of this kind appears to exist.

ENGLAND.

Dr. Thudichum* reported, in 1864, as follows :—

"About eight years ago, I instituted an inquiry into the frequency "with which Echinococcus occurs in the cattle killed in the district of "the parish of St. Pancras, north of the Euston-road, London. Amongst "the worst classes of sheep sold in Camden Town, I then sometimes "could not find a single animal that was entirely free from Echinococci. "My present impression is that at least a third, if not a half, of all the "sheep which I then examined contained Echinococci in some state or "other of development, varying in size from a pin's head to a man's fist."

In 1864, however, the disease was rare in the sheep slaughtered, but then the author remarks that his observations in 1856 were made during winter and the early spring months—January to March ; but in 1864 the investigation was carried on in the three months ending with July.

"Sheep are born in spring only ; they are infected with parasites with "the greatest facility during the first year ; much less easily, perhaps "not at all, with Tæniæ, at least, during the second and subsequent "years. Infection with the eggs of Tænia probably occurs with greater "facility in wet years than in dry years. It occurs probably with "greater facility during spring than during summer. As regards Echino- "coccus in the country, it must necessarily occur more frequently in "spring than in other seasons, because most sheep are killed during "winter, and the Tænia developed in dogs after such killing have a "duration not exceeding fifty-four days."

* Report by Dr. John Louis William Thudichum on the Principal Parasitic Diseases of the Quadrupeds which are used for Food. Seventh Report of the Medical Officer of the Privy Council. London, 1864, p. 334.

Echinococcus was scarce in the pigs, and also in oxen and cows, killed in London during Thudichum's period of observation.

ICELAND.

With regard to this country, however, the question has been investigated by an excellent authority, viz., the late Dr. J. Hjaltelin, of Reykjavik, who for many years was the chief medical officer for Iceland. He writes*—

"I have for many years been investigating how frequent this disease "is in the Icelandic sheep, and I have come to the conclusion that "traces of it are found in more than every fifth sheep. Nearly all the "peasants have ascertained that this parasite may be found in every "third sheep that is more than three years old. In a district called "Skaptar-syssel, with about 3,000 inhabitants and 22,000 sheep, the "Echinococci are said to be found in every adult sheep, and it is "worth attention that just in this district every third adult person is said "to have Hydatids. Whether this is exact or not I cannot tell, but thus "it was stated to me by a physician who has been serving there for more "than thirty years."

This is what might be expected from the well-known prevalence of Hydatids in man in this country.

BRITISH INDIA.

It has already been mentioned that Hydatid infection is not common in the natives of India, and, consequently, it is somewhat remarkable to learn that in some parts, at least, the disease is by no means rare in the domestic Herbivora, for Cobbold† writes—

"One of the most valuable contributions to our knowledge of the "prevalence of Hydatid disease affecting animals is that supplied by "Dr. Cleghorn, from a statistical table constructed by the executive "commissariat officers stationed at Mooltan. The record in question "shows that, out of 2,109 slaughtered animals, no fewer than 899 were "affected with Hydatid disease. This is equal to more than forty-two "per cent. In the majority of cases both the lungs and liver were "affected; cysts were found 829 times in the liver and 726 times in the "lungs; in a few instances they were present in the kidneys, and also "occasionally in the spleen.

"The inference from all this is, that in India, if not elsewhere, the "Echinococcus disease is much less common in man than it is in animals. "The explanation is simple enough, since cattle have more ready access "to, and less scruple in partaking of, filthy water or food, in or upon "which the eggs of the Tænia Echinococcus abound."

* Reports upon the Progress of Practical and Scientific Medicine in different parts of the World, edited by Horace Dobell, M.D. London, 1870, page 288.

† Parasites. London, 1879, p. 124.

AUSTRALIA.

Unfortunately, there exist at present no statistical data illustrative of the frequency of Hydatids in the domestic Herbivora.

However, it is a matter of common observation that the sheep, especially those pastured in the south-eastern district of South Australia, are to an enormous extent infested with Echinococcus; in fact it has been stated to the author, that infection is here the rule.

And even as regards other parts of this colony, the disease is very common in sheep. For example, in the year 1880, fifty sheep slaughtered on a sheep station about 100 miles north of Adelaide, when examined by a highly intelligent observer, were found infected as follows:—"Ten per cent. of these were badly diseased in "lungs and liver both; six per cent. were diseased in the lungs "only; and six per cent. in the livers only."

In many parts of the same colony the kangaroos and other native game are highly infested with the same pest.

It is remarkable that in Australia, whose wealth so largely consists of its flocks and herds, so little attention has been paid by its Governments to the diseases originated by parasites. It is to be hoped that this matter will, ere long, receive the earnest attention that its importance demands. No better insurance premium could be paid in the interests of stockowners than money expended in the establishment of a scientific veterinary institution in each of the metropolitan cities.

The most important factor in the spread of Echinococcus disease is **the frequency with which the dogs in any given country are found infected by Tænia Echinococcus.** Comparatively little attention appears to have been paid to this subject, and the published facts are but few.

GREAT BRITAIN.

Cobbold* states that—

"No person has seen the Tænia Echinococcus in any English dog "which has not been previously made the subject of experiment, but "considering the prevalence of Hydatid disease amongst us, there can be "no doubt that English dogs are quite as much, if not more, infested than "continental ones; probably at least one per cent. of our dogs harbor "the mature Tapeworm."

* Parasites, p. 125.

It is surprising, considering the frequency of Echinococcus in sheep slaughtered in London, that the adult parasite is not more common in the dogs.

GERMANY.

Naunyn* states that Tænia Echinococcus must be a rarity in the town dogs of Berlin, for, in about twenty dogs carefully examined by him, it had not once been met with.

Leuckart† mentions, however, that the intestines of dogs containing Tænia Echinococcus had often been sent to him from Göttingen; whilst, in Giessen, he had never met with it except after experimental feedings.

FRANCE.

Davaine, in the most recent edition of his classical work,‡ mentions no facts bearing upon the frequency of the parasite in this country.

DENMARK.

Krabbe || examined at the Veterinary School at Copenhagen, during the years 1860-63, 500 dogs of all sizes and ages. *In only two instances* did he meet with Tænia Echinococcus, being at the rate of 0·4 per cent.

ICELAND.

Krabbe,§ during a visit paid to this country in the year 1873, examined 100 dogs procured from various parts of the country, and he found this Tapeworm present *in twenty-eight instances.* This is precisely what might have been expected from the known prevalence of Hydatid disease in this country.

AUSTRALIA.

Towards the close of the year 1882 and the early part of 1883, the author commenced an investigation, with the view of ascertaining the prevalence of Tænia Echinococcus in the dogs of the

---

* Archiv für Anatomie, Physiologie und Wissenschaftliche Medicin. Reichert und Du Bois Reymond, 1863, No. 4, page 415.

† Op. cit., footnote to page 750. ‡ Traité des Entozoaires, Paris, 1877.

|| Recherches Helminthologiques en Danemark et en Islande, par H. Krabbe. Copenhagen, London and Paris, 1866, pp. 3 and 11.

§ Op. cit., pp. 21 and 52.

cities of Adelaide and Melbourne, as well as in those of the south-eastern district of South Australia.

Although prevented by the claims of his daily professional duties from prosecuting this inquiry to the extent that its importance demands, the author yet ventures to think that the facts already ascertained by him fully account for the very serious prevalence of Hydatid disease in the localities where investigation has been made. The result of the inquiry has been the discovery that this dangerous parasite is present in a much greater proportion of dogs, in some parts of Australia, than Krabbe found to be the case even in Iceland.

The mode of examination adopted was as follows:—The small intestine of the animal was secured by ligatures immediately below the pylorus, and above the ileo-cœcal valve, and removed from the body with its contents. It was then divided into two halves, and each portion was washed out thoroughly by a strong stream of water passed through its interior. The washings were received in large glass vessels, and little by little every portion was examined in a large shallow tray, the sides and floor of which were painted jet black. When necessary the washings were diluted with more clean water, until it was possible to see distinctly the most minute objects visible by the naked eye, or through an ordinary hand-glass.

The intestines were in many instances afterwards slit up in the usual way, and carefully examined; but when present at all, this minute Tapeworm was always found in the washings.

Almost invariably, Tænia Echinococcus was found only in the upper half of the bowel, and Tænia Cucumerina in the lower half. When the larger species of Tapeworm were found, it was usually at about the middle or lower half of the intestine.

It is well known to helminthologists that the three larger Tæniæ of the dog, viz., T. serrata, T. cœnurus, and T. marginata, have a very close resemblance to one another; the specific distinctions of the adult Tapeworms are indeed by no means striking, and depend upon differences in the average length and size of the Tapeworm colony, in the dimensions of the hooklets, and in the ramifications of the uterus.

Table showing the Result of Examination of Dogs in Various Places in South Australia.

No.	Kind of Dog.*	Whence Procured.	Date of Examination.	Tænia Echinococcus.	Tænia Cucumerina.	Tænia Marginata.	Ascaris. Species (?).
1	Mongrel	Adelaide	—	None	Several	—	—
2	"	"	July 9th, 1882	A great number	—	Some specimens	Several
3	"	"	" 9th, "	None	Several	—	A few
4	Greyhound	"	" 17th, "	None	Several	—	Some
5	Retriever	"	" 17th, "	Hundreds	A few	Eight specimens	—
6	Terrier	"	Aug. 26th, "	Large numbers	Several	—	—
7	Water Spaniel	"	" 27th, "	None	Many	A few	—
8	Greyhound	"	Sept. 3rd, "	A few dozens	A few	—	—
9	Black and Tan Terrier	"	" 5th, "	None	A great many	—	Several
10	Kangaroo Dog	"	" 5th, "	None	Several	—	None
11	Mongrel	"	" 5th, "	A few	A few	—	—
12	Collie	"	" 14th, "	None	Several	Two	—
13	—	"	" 17th, "	Hundreds	Several	—	More than 100
14	Spaniel	"	Oct. 7th, "	About a dozen	Several dozens	—	Two specimens
15	Retriever...........	"	" 9th, "	Two specimens	—	One	Several
16	Scotch Terrier	"	" 10th, "	None	A few	One	—
17	Retriever...........	"	" 15th, "	None	Many	—	Several
18	Newfoundland	"	" 22nd, "	Four specimens	Hundreds	Three	—
19	Black and Tan Terrier	"	" 25th, "	None	Scores	—	—
20	Mongrel	"	" 25th, "	None	Scores	One	—
21	—	Millicent	Dec. 15th, "	None	No record	No record	No record
22	—	"	" 15th, "	None	"	"	"
23	—	"	" 15th, "	None	"	"	"
24	—	"	" 15th, "	Hundreds	"	"	"
25	—	Mount Gambier	" 27th, "	None	"	"	"
26	—	"	" 27th, "	None	"	"	"
27	—	"	" 27th, "	None	"	"	"
28	—	"	" 27th, "	Numerous	"	"	"
29	—	"	" 27th, "	Numerous	"	"	"
30	Mongrel	Penola	Jan. 1st, 1883	Thousands	"	"	"

* Probably in no case was the dog pure bred, but when any breed was predominant in the animal, it was accordingly described.

The author, therefore, cannot feel assured that his diagnosis of the larger Tapeworms has been invariably correct; as regards Tænia Echinococcus and T. Cucumerina, no possible error can have been made. In all cases where, from the fewness or damaged condition of the specimens of T. Echinococcus found, the least doubt existed, the specimens were invariably examined microscopically.

In many cases, round worms were also found present, sometimes in very large numbers. No attempt to actually count the entire number of specimens of any of the Entozoa present was possible, with the limited time at the disposal of the observer.

The dogs examined were stray unregistered animals, captured by the police authorities in the various localities. Those examined at Adelaide were carefully examined, but the dogs examined in the south-eastern district, *i.e.*, at Penola, Millicent, and Mount Gambier, came under observation under circumstances and conditions very unfavorable to an exhaustive investigation. It is therefore not unlikely that the presence of this minute parasite may have been overlooked in some cases.

The general result of the inquiry is, however, quite clear and very important, viz :—*That not less than forty per cent. of the unregistered dogs examined, both in the City of Adelaide and the various parts of the south-eastern district of South Australia, were infested with Tænia Echinococcus.*

It should be mentioned, however, that during the months of June, July, and August, 1883, six dogs captured and destroyed by the police in Adelaide, were examined ; in none of these could any specimens of Tænia Echinococcus be found, and at no previous time had so many dogs in succession been found free from the parasite. The explanation is probably this : The first series of dogs examined were, for the most part, vagrant and homeless animals, which must have picked up their living from slaughter-houses, &c. The second series were a small fraction of a considerable number of dogs destroyed by the police because they were not registered. Many of these, without doubt, had nominal owners, by whom they were fed, although they had not been duly registered.

Tænia Cucumerina was very much more common, and although the author unfortunately neglected to record its occurrence in each instance, he is under the impression that this Tapeworm was rarely

if ever absent from any dog examined, either in South Australia or in Melbourne. It seeems to be everywhere common in the domestic dog. Thus Krabbe met with it in forty-eight per cent. of the dogs in Copenhagen, and in fifty-seven per cent. of those in Iceland. Through the discovery of Melnikow, it is now known to be derived from the louse of the dog (Trichodectes Canis).

It is usually present in large numbers, and, in one instance that came under the notice of the writer, the number present was enormous; for the lower part of the intestine of this dog was densely covered with vast numbers of these parasites.

As regards the larger Tapeworms of the dog, Tænia Cœnurus is derived from the well-known cystic parasite, Cœnurus Cerebralis, which, by its presence in the brain, causes the disease known as the "gid," "staggers," or "vertigo," in the sheep. As far as the writer is able to learn, this disease is rare in the sheep of South Australia and Victoria, and consequently the adult parasite is not likely to be common in the dogs. Tænia Serrata is derived from the Cysticercus Pisiformis, infesting hares and rabbits. Tænia Marginata is derived from Cysticercus Tenuicollis of sheep, oxen, and pigs.

VICTORIA.

The only place where the author has had the opportunity of examining dogs in this colony is Melbourne.

The dogs examined—ten in number—were obtained from the town of Hotham, which is in reality a part of Melbourne, and the writer is indebted to Mr. Charles E. Randall, the Town Clerk of Hotham, for the supply of the stray street dogs in question.

Table showing the Result of the Examination of Ten Dogs in Melbourne.

No.	Kind of Dog.	Date of Examination.	Tænia Echinococcus	Tænia Cucumerina.	Tænia Marginata.	Ascarides.
1	Male Retriever	1883. Jan. 15	None	A few	—	—
2	" Mongrel......	"	Hundreds	Several dozens	Three	—
3	" "	"	Thousands	—	Several	Many
4	" Scotch Terrier	"	Very few	Several	Several	—
5	" Retriever	"	None	—	—	A very large number
6	Female Scotch Terrier	"	None	—	—	—
7	" Mongrel ..	"	None	Numerous	—	Numerous
8	Male Mongrel......	"	None	Many	—	A few
9	" Newfoundland	Jan. 16	A few	—	Several	A few
10	Female Spaniel	"	A few	Many	—	—

From the foregoing table, it will be seen that five out of the ten dogs examined at Melbourne were infected with Tænia Echinococcus, so that, in this respect, the street dogs of some parts of Melbourne are quite as dangerous as those of Adelaide.

It is to be hoped that observers interested in this subject will institute a more extensive investigation into the matter, not only in the various districts of Victoria, but in all the other colonies of Australasia.

Conditions Influencing the Mutual Infection of Dogs and Domestic Herbivora.—Dogs must receive their infection by eating the flesh, and especially the viscera, of animals containing living hydatids, and this must take place chiefly in consequence of the careless habit of admitting these animals to slaughter-houses, public abattoirs, offal pits, and butchers' shops. In the cities of Melbourne and Adelaide, and in many of the country places of both the colonies of Victoria and South Australia, the author has satisfied himself, by personal observation, that not the smallest precaution is taken to exclude dogs from such sources of infection.

In the country districts an enormous destruction of sheep takes place by the ravages of dogs, and legislative enactments have been made to check the loss arising from this cause.

Again, the indigenous animals, such as kangaroos, are in some parts highly infested with Hydatids, and the writer has been informed that it is common to permit the hunting dogs to regale themselves with the livers of the animals captured in the chase. In this way, it is easy to explain the enormous prevalence of Tænia Echinococcus in some parts of Australia.

How long the Echinococcus-heads can retain their vitality after their enveloping cyst has been removed from the living body of its host is unknown, and it certainly varies much according to external circumstances. For example, the writer has found scolices in full life sixty hours after their removal from the human liver, whilst, on another occasion, Hydatid fluid was found swarming with vibrios, and quite half the contained scolices were dead, twenty-nine hours after removal from the host. Both were specimens of normal Hydatid fluid, and were placed under exactly the same conditions, except that, in the former case, the temperature of the air ranged between a minimum of 45° 3′ F. to a maximum of 61° 3′ F.; whilst in the latter instance the temperature ranged from 56° 1′ F. to 70° 3′ F.

It is probable that decided putrefaction of the cyst or its contained fluid will determine the death of the enclosed Echinococci. Hence it follows that, in cool weather, dogs are far more likely to acquire Echinococcus infection than in hot weather.

Modes of Infection in Man and the Domestic Herbivora.—The cystic form of Echinococcus has a rather wide distribution in the animal world; thus, among the animals which have been found to serve as its "hosts," may be mentioned—man, the monkey, the sheep, ox, pig, deer, camel, giraffe, the horse,* ass, zebra (Huxley), kangaroo, squirrel (R. Leuckart). It is stated to have been met with in the domestic cat, in the panther (Hyde Salter), and the author has specimens procured from the abdomen of a lemur from Madagascar. Moreover, it appears to be not even confined to Mammalia, for von Siebold found it in the lung of a turkey,* and by both von Siebold and Pagenstecher it was met with in the peacock.†

Practically, the most important "hosts" for the cystic worm are man and the domestic Herbivora.

It is, of course, a matter of primary importance to consider the media by which the eggs of the Tapeworm inhabiting the dog obtain entry into the bodies of these hosts.

It is evident that climatic conditions alone can exercise no decided influence in any direction, for neither the cold of Iceland nor the heat of Australia prove unfavorable to the spread of the infection, and we naturally look for some conditions, common to both countries, to explain the striking prevalence in these lands.

Whatever enables the Tapeworm eggs to enter the body must act as one of the "determining causes," and among these causes must be considered the objectionable habit of permitting dogs to lick the faces and hands of adults and children.

That communication in such a way is not very rare, the author has had reason to know; for example—

In February, 1879, a child aged two years and one month was brought to him, suffering from an enlargement of the liver, which had been first noticed by his mother about six weeks previously. The tumor was aspirated, and found to be an Hydatid

---

* Cobbold. Entozoa. London, 1864, p. 261

† See Rudolph Leuckart. Die Parasiten des Menschen. Zweite Auflage. Leipsic, 1879. Footnote to page 743.

cyst, containing three fluid ounces of clear watery fluid. The extreme youth of the child induced the writer to investigate closely the probable source of infection, and it was concluded, with almost absolute certainty, that it could be traced to a bulldog, which was a constant companion of the child. The mother had noticed frequently that the child was in the habit of sucking the bones which had been gnawed by the dog, and lay on the ground about its kennel, and thus, without doubt, the infection had been conveyed from the dog to the child.

But, although direct infection is possible, it is very unlikely to be common, for, as a rule, pet dogs are well fed by their owners, and hence they do not incur the same risks of Hydatid infection as vagabond dogs do, which pick up their living anyhow and anywhere.

ICELAND.

As regards the domestic Herbivora, it is pretty evident that both through their drinking water and their pasture, the infection is conveyed to them. In Iceland bogs and swamps abound, especially in the lower-lying country where the farms are most numerous.

"Bog in Iceland *clothes the hillsides*, as well as the bottoms and " 'flats,' that is, any low alluvial land; it is easily discovered from afar " by the dull red tint of iron rust and the snow-white spangles of cotton " grass. There are two forms of profile, one lumpy, tussocky, and what one " traveller calls 'hassocky,' 'like the graves of a deserted churchyard,' " the other a plane, the swamp pure and simple, often flooded after rains " and in the dries *(sic)* provided with two or three veins, into which " animals plunge, struggle, and fall."*

Again, according to Madame Pfeiffer, for a long distance round Reykjavik (the capital town), the ground consists of stones, turf, and swamps. The latter are mostly covered with hundreds upon hundreds of great and small mounds of firm ground.† It is evident how easily the ova of Tænia Echinococcus may accumulate in such water, and thus communicate infection to the animals drinking it. Then the grass and hay upon which the stock feed is, very probably, a source of infection. Baring-Gould,‡ remarks that the

---

* Ultima Thule, or a Summer in Iceland, by Richard F. Burton. London and Edinburgh, 1875, p. 51.

† A Visit to Iceland and the Scandinavian North, by Ida Pfeiffer. English edition. London 1853. p. 81.

‡ Iceland, its Scenes and Sagas, by Baring-Gould, M.A. London, 1863, p. 45.

only land cultivated in Iceland is the *tùn,* which is a meadow surrounding the farmhouse, varying in extent according to the number of cows kept on the farm; this field is dressed with their dung, and produces the hay which constitutes the food of the cattle during the winter.

The grass and hay of this small meadow must easily entangle the minute eggs of the innumerable Tæniæ harbored by the numerous dogs of an Icelandic homestead.

As regards the media of infection in man, here too the drinking water must play an important part; but, in addition to this, the uncleanliness of the people offers many opportunities for infection. All travellers to this country draw special and often frequent attention to the personal and domestic uncleanliness of the Icelanders. Madame Pfeiffer remarks,* "I found the cottages "of the peasants everywhere alike squalid and filthy."

Cows, sheep, and dogs live under the same roof as the family, during the long weary months of Iceland's bitter winter.

Baring-Gould describes the general character of one of the better farm-houses thus† :—

"Looking at the front of the house, one observes five or more gables "made of wood, painted red or black, wedged between turf walls from "four to ten feet thick. The apex of the gable is seldom above twelve "feet from the ground, very generally only eight, and is adorned with "wooden horns or weather-cocks. Under the central gable is the door, "around which are crooks, upon which the stockings of the family are "hung to dry on windy and sunny days. Passing through the door, "one enters a long dark passage, too low for a person to stand upright "in it, leading to a ladder, which gives access to the *bathstófa*, or common "eating, working, and sleeping apartment. This room is lighted by "two or more glass panes, three inches square, inserted in the roof, and "sealed in, so as never to be opened for the admission of pure air. The "walls are lined with beds, and the end is divided off by a wooden "mock partition (never closed by a door) so as to form a compartment. "Here the father and mother of the family sleep, together with such "visitors as cannot be accommodated in the guest-chamber. In the "*bathstófa* sleep all the people connected with the farm, two or even "four in a bed, with the head of one at the feet of the other. The "beds are lockers in the wall, lined with wood, and with wooden par- "titions between them. They are arranged along the room, much like "the berths in a cabin, or the cubilia in a catacomb. Each is supplied "with a mattress, feather-bed or quilt, and home-woven counterpane.

* Op. cit. p. 69. † Op. cit., p. 59, 60.

"The Icelanders not only sleep in this room, but eat in it, making sofas "of the beds and tables of their knees. In it is spent the long dark "winter, with no fire, and each inmate kept warm by animal heat alone. "The stifling foulness of the atmosphere can hardly be conceived, and "indeed it is quite unendurable to English lungs." He adds that "on "the trampled ground in front of the house are emptied all the slops, and "on it is cast the refuse that cannot be trodden into the floor within "doors. There is neither order nor neatness in an Icelandic house."

The mode of cleaning plates is to give them to the dogs to lick, and even the stock-fish, that constitutes their staple article of diet, is heedlessly piled on the filthy floor of the dwelling-house, ready to become befouled by the dogs.

Owing to the diet of the people, scurvy is common, and hence raw vegetables, such as cabbage, are a delicacy, and are greedily consumed, and these being grown adjacent to the house, naturally give another medium of infection to the people.

No doubt, then, the three chief agents for the conveyance of the ova into man in this country are—the use of bog, swamp, and other infected drinking water, the habit of allowing the dogs to cleanse the plates by licking them, and the use of raw vegetables as salads.

The common people appear to be quite ignorant of, or indifferent to, the causes of the scourge, for when the Athling, in 1871, with a view of diminishing the number of useless dogs, imposed an annual dog-tax upon all exceeding a certain number on each farm, this measure appeared to have caused much ridicule among the people, who asked why the cats also were not assessed? So that in Iceland ignorance is the parent of disease and death, as it is everywhere else.

AUSTRALIA.

The principal medium for the conveyance of the Tapeworm eggs into the domestic Herbivora and man is, without doubt, the drinking water.

The colonies of New South Wales, Victoria, and the southern part of South Australia are essentially dry countries.

The average annual rainfall varies in the different colonies, and also, very widely, in different parts of the same colony, but it is nowhere great.

Taking Australia as a whole, the fewness of large rivers is a remarkable geographical feature. The watercourses of the country are usually creeks, which may run bank high in the rainy season, but in the summer either become quite dry or are represented by detached water-holes, of different, but usually small, dimensions.

The larger cities and towns are for the most part tolerably well supplied with water, but in the country districts, tanks, water-holes, and dams supply the drinking water for man and beast. Frequently an unenclosed water-hole or dam is the sole water supply available. It is evident how easily such water may contain the ova of various entozoa, including Echinococcus. The eggs deposited on the ground are blown in by the winds and washed in by the rains, and thus the infection becomes spread in the animals drinking the water.

The statistical returns already recorded show that the most highly infected part of the whole of Australia is the south-eastern district of the colony of South Australia.

This is not only a matter of common belief, but it is shown to be true by the returns of the Mount Gambier Hospital.

In this institution, during the fourteen years from January, 1869, to January, 1883, about one case out of every sixty-two In-patients was Hydatid disease.

From data supplied by Mr. A. K. Varley, it appears that "all "the cases except one are from the south-east, and nearly all from "swampy country."

Although widely differing in almost every respect, there is one point of resemblance between this territory and Iceland, viz., that in both there are large areas of swampy surface. In Australia, however, there is a much greater diminution of swamp-covered surface during the summer than in Iceland. And from this cause, no doubt, the greatest risk of infection must be encountered, when water procured from water-holes or small swamps is drunk during the summer, and yet this is precisely the time when dwellers in the Australian "bush" are tempted by thirst to drink such water, there being perhaps no water safe to drink within many miles of the spot.

PART VI.

MEASURES FOR THE PREVENTION OF HYDATID DISEASE.

PART VI.—MEASURES FOR THE PREVENTION OF HYDATID DISEASE.

Measures for the Prevention of Hydatid Disease.— In the first place, the number of dogs, especially of stray and ownerless animals, should be diminished, and this is evidently the business of the State.

In the colonies of New South Wales, Victoria, and South Australia, various legislative measures have been at different times passed, with the object of compelling the registration of dogs, and of ensuring the destruction of unregistered or ownerless animals.

In New South Wales, there exists "An Act for abating the "nuisance occasioned by dogs in the streets of certain towns and on "highways in New South Wales." (25th August, 1835.)

This was amended and extended by another Act, bearing date July 22nd, 1875.

In consequence of these laws, registration of dogs over six months old is rendered compulsory, and all dogs found at large, "without being under the immediate custody, protection, or control "of some competent person, or unless such dog shall have a collar "round its neck, with the name and address of its owner legibly "engraved thereon," shall be immediately liable to be seized and destroyed. The operation of the Act may be extended by the Governor and his Executive Council to any police district in the colony.

The present fee for registration is two shillings and sixpence per annum, and the enforcement of the law is made compulsory upon police constables, under a penalty of ten to twenty shillings for every dog found at large in the district under their charge.

These Acts, if thoroughly carried out, would no doubt prove very efficient.

In Victoria, an amended Dog Act was passed in 1864. It provides for the registration of all dogs over six months old, at an annual fee of five shillings, and exacts that "every registered dog, "except a dog belonging to and being in a pack of not less than "twenty-four dogs, used solely for hunting purposes, shall have a "collar round its neck, with the words 'Registered at,' specifying "the place of its registration and the name and address of its "owner, engraved legibly thereon."

Unregistered or stray dogs are to be "seized by the police or "by the officers of the district board, or of the shire or borough, as "the case may be." As a matter of fact, the enforcement of the Act in the cities and towns is entrusted to the municipal authorities, and it is in many, if not most, cases regarded merely as a source of revenue, and is certainly not carried into operation to the degree that it should be.

In Melbourne, for example, the proviso with regard to the wearing of collars by registered dogs is practically ignored, for during a visit of the writer to that city in January, 1883, not one dog out of every ten met with in the public streets had a collar on.

In South Australia, Dog Acts were passed in 1860 and 1861, which, however, were repealed in favor of the Dog Act of 1867. This provides that all dogs over three months old shall be registered, under a penalty to the owner of not less than one pound nor more than six pounds. The annual registration-fee is five shillings. Dogs unregistered or not provided with collars may be seized by any person, and constables and Crown lands rangers are especially ordered and required to seize them. Such animals, when not claimed in accordance with the Act, are to be destroyed.

A reward of two shillings and sixpence is offered to any person destroying such ownerless or unclaimed dog.

There is a stringent clause, compelling owners of dogs to provide them with suitable collars, under a penalty of from five to forty shillings.

The Vermin Destruction Act of 1882 includes within its scope "Dogs run wild and dogs at large," and authorises in Schedule II.—"Moneys payable to boards in respect of the destruction of vermin"—for every dog, the sum of ten shillings.

From this it will be seen that very ample legal powers exist for the enforcement of registration and the destruction of unregistered dogs in South Australia.

These laws were framed with no idea of checking Hydatid disease, but simply to prevent the destruction of stock by dogs, and to limit the annoyance to the public from wandering and ownerless animals. If duly carried out, they will, however, prove of the greatest value in diminishing the risks of Echinococcus infection.

It is important to prevent the infection of dogs by eating the viscera of sheep, cattle, and pigs containing Hydatid cysts. Dogs are permitted to enter slaughter-houses and prowl about offal heaps, or pits containing butchers' refuse; and thus they have many opportunities of swallowing Echinococci, and consequently of propagating the disease. The remedy is evident, viz., no dog should, under any circumstances, be permitted to enter butchers' premises or public abattoirs. Uncooked meat should never be given to dogs. The mere fact of boiling, or otherwise cooking meat, ensures the destruction, not only of Echinococcus cysts, but also of Cysticercus (measles), Cœnurus, Trichina, &c.

Some good might also be done by the occasional "physicking" of dogs, but only if the excreta be burnt at the same time. Dogs kept on the chain should have their kennels and the ground adjacent frequently cleansed with boiling water. Finally, the water supply should be kept scrupulously pure from the invasion of dogs. They should not be allowed to swim in reservoirs, nor to drink from the same source as man or sheep.

As far as possible, tanks should be protected from the entry of dust, for it is highly probable that the minute eggs may, during the summer months in Australia, be swept by the winds and carried by dust storms into water tanks protected from the direct access of dogs.

Finally, filtration or boiling will diminish greatly the risk of infection by drinking water, and it should be remembered that the cleanest looking water may still contain great numbers of Echinococcus eggs.

The ova are of such dimensions that probably any good filter will prevent their passage through it.

APPENDIX.

Upon the Breeding of the Tænia Echinococcus from the Hydatids of Man.

It has been mentioned in a previous part of this work *(vide* p. 80 and *seq.)* that more or less successful attempts had been made by Finsen and Krabbe, as well as by Naunyn, to breed the adult Tapeworm in the dog from the Echinococci of man; but that the experiments of these observers could not, in any instance, be regarded as entirely satisfactory. I am, on this account, the more gratified to be enabled to record two cases, the success of which is beyond any reasonable objection. For this purpose it was necessary—

1. To procure dogs which could not be suspected of having been infected previously.
2. To place the animals under circumstances in which it would be impossible for them to acquire infection from any accidental source.
3. To feed them with the *living* Echinococci of man.
4. In order that the experiments should be completely successful, it was necessary, not only that the Tapeworm should be found in the intestine of the dog, but also that it should be found in numbers proportionate to the number of Echinococcus-heads administered, and, moreover, the stage of development reached by the Tapeworms should correspond to the date of the experimental feeding.
5. That no kinds of Tapeworms should be present, excepting such as could be duly accounted for.

The circumstances of the experiments were as follows:—

On June 25th, 1883, I purchased four puppies, which were said to be a cross between a bloodhound and mastiff. At the time they came into my possession, they were seven weeks old, and up to that moment they had never left a small enclosed yard, in which their mother was chained. Beyond the maternal milk, they had received no food, except cooked scraps from the kitchen of their owner, and, indeed, very little of anything except their mother's milk.

On the evening of June 25th they were enclosed in a recently disused powder magazine situated on the North Park Lands, Adelaide. The magazine in question is now the property of the University of Adelaide, and its use for the purpose of these experiments was kindly granted to me by the Council of the University.

During the seclusion of the dogs, they received only cooked food from my own kitchen, and rainwater collected from the roof of the magazine and stored in a new tank within the magazine enclosure.

The animals remained in good health and grew rapidly.

On July 5th I aspirated a Hydatid tumour situated in the epigastrium of a woman, who was then a patient under my care in the Adelaide Hospital. Two ounces of *nearly clear* Hydatid fluid were removed, and as I thought I could see, with the naked eye, a few groups of scolices floating in the fluid, I administered it mixed with milk to one of the dogs. The feeding took place about two hours after the fluid was removed from the human body.

The dog continued in good health and was killed by prussic acid on August 5th, *i.e.* on the 31*st day* after the feeding. No Tapeworms were found, but several Ascarides were present in the small intestines.

This experiment was, therefore, quite negative in its results; but as the patient had been, some years previously, operated on for the same Hydatid, and as consequently it is very doubtful whether any living scolices were administered, it was useful only in establishing the original freedom of the dogs from Echinococcus.

For some months it was impossible to procure any living scolices, but on October 16th I fortunately met with a suitable case. The patient, a healthy young man, aged 25, was found to have a Hydatid cyst on the upper surface of the liver, which was aspirated by me on October 16th, 1883. Twelve ounces of perfectly normal Hydatid fluid were removed. Upon microscopic examination, a considerable number of scolices, mostly collected into groups, were found.

The fluid was allowed to stand in a decantation glass, protected from dust by a glass shade, for a couple of hours, and the bulk of the supernatant fluid was then poured off. Three and a half hours after its removal from the man, about half the residue, containing many groups of scolices, was poured down the throat of one of the dogs; most of it seemed to be swallowed, but some was coughed up. Milk was then poured down the dog's throat, and afterwards a further quantity of milk was supplied in a vessel; this was readily lapped by the animal.

On the next day, October 17th (about sixteen hours after the fluid was obtained), most of the remaining scolices were administered, being poured down the throat of the dog in about an ounce of their native fluid. As before, a supply of milk followed, this time with the addition of breadsops.

Twenty-nine hours after the removal of the Hydatid fluid, I examined some of the contained scolices, and found a considerable proportion of them alive and moving actively on the hot stage (Temperature 100° Fahr.).

On November 18th (thirty-two days after the feeding), the dog was killed with chloroform, and the small intestine and stomach were care-

fully examined by Dr. Whittell and myself. No appearance of Tænia Echinococcus could be recognised on the lining of the intestine, but a great number of Tænia Cucumerina were noticed, partly in the lower portions of the upper half of the small intestine and in greater numbers in the lower half. No round worms could be found. The lining membrane was washed with warm water, and the washings were then carefully examined.

In the washings of the upper half we found about 100 specimens of Tænia Echinococcus, out of which about eighty complete worms were collected; many terminal joints also were seen. In the washings of the lower half of the bowel, I found six complete specimens.

These Tæniæ were evidently unripe, and none of them showed four joints, or, indeed, proglottides containing ripe hard-shelled eggs. Many of them had three segments, including the head, but not a few consisted only of a head, unsegmented neck, and one terminal proglottis.

In the terminal joint, the cirrus, cirrus-sac, and coiled vas deferens were seen, and in some cases faint indications of egg-formation.

The head showed the usual suckers and rostellum, and in several cases a double circlet of hooklets.

The worms varied from about $\frac{1}{12}$ to $\frac{1}{8}$ inch (one to one and a half lines) in length, and were so fragile, that a portion of the brood, carried carefully in a bottle containing camphor water for a distance of a few miles, were found by Dr. Whittell to be, without a single exception, broken into separate segments.

The circlets of hooks were usually absent or incomplete, probably in consequence of mechanical injury, but in one instance a complete crown was found. However, in consequence of the position of the head of this specimen on the slide, it is difficult to accurately count the hooks. They appear to be from thirty-five to forty in number.

The dimensions of the hooklets, as measured by Dr. Whittell, were: maximum length, $\frac{1}{950}$ inch; length of root-processes, $\frac{1}{1420}$ inch; greatest transverse diameter at junction of claw with root-process, $\frac{1}{2500}$ inch.

The root processes were well developed.

It should be mentioned, that on October 14th, *i.e.*, four days before the date of the examination, this dog was allowed by a careless attendant to escape for twenty-four hours from the magazine, but as it was known to have concealed itself on the premises of a neighbor for the whole of the time, and as it was impossible for it to have procured any meat in this period, the experiment cannot be regarded as vitiated. Besides, the short space of time (four days) that intervened between the temporary escape of the dog and its examination, renders it certain that the specimens of Tænia Echinococcus found were the result of the experimental feeding thirty-two days before.

As regards the specimens of Tænia Cucumerina present, these owed

their origin to dog-lice swallowed by the animal, and the lice themselves were, no doubt, communicated to the dog in its babyhood by its mother.

A third dog was, on November 16th, 1883, fed upon a considerable number of daughter cysts and scolices, procured from the body of a woman who died of phthisis at the Adelaide Hospital, on the afternoon of the previous day. A further "feeding" from the same source was administered on the morning of the 17th. Living scolices were found present in a portion of this "feeding" ten hours after the rest had been given to the dog. On December 10th, 1883, Dr. Dunlop supplied me with about eight ounces of nearly clear Hydatid fluid containing a great number of scolices. The fluid had been obtained from two Hydatids occupying the pelvis of a woman, who had died in the Adelaide Hospital on December 9th. A considerable dose of the scolices, mixed with milk, was given to the same dog twenty-five and a half hours after the decease of the patient. This "feeding" contained some living scolices, but the majority of those examined upon the hot stage exhibited no movement when warmed, and, hence, were probably dead. On December 30th, *i.e.*, forty-four days after the first feeding, and twenty days after the second dose of scolices, the small intestine of this dog was examined by Dr. Whittell and myself. Contrary to expectation, we found no ripe Tænia Echinococcus; but, after a patient examination, we found one complete but juvenile specimen of this worm, and the terminal joints of seven others. These were quite young, being very small (about $\frac{1}{12}$ inch when complete) and extremely fragile. However, the specimens showed plain indications of the generative organs, but no distinct egg-formation. Their appearance is well depicted by Dr. Dunlop, in Plate III., which was sketched at the time.

If these figures be compared with those in Plate IV., it will be evident that the Tæniæ present were the result of the second feeding, so that they were twenty days old. The only complete worm found had three distinct joints (including the head), but it had lost its hooklets, probably from the endosmosis of water.

It is likely that in the case of both "feedings" most of the scolices were either dead or dying, for the fluid in which they were contained showed signs of commencing decomposition. This, probably, accounts for the small number of Tæniæ found in the dog. Besides the specimens of Tænia Echinococcus, there were some hundreds of Tænia Cucumerina, and one small Ascaris in the small intestine.

The fourth dog was unfortunately allowed to escape.

I am indebted to Dr. Dunlop, of the Adelaide Hospital, for the drawings of the Tæniæ bred in the experiments recorded (see Plates III., IV.), and also for the illustrations of ripe Tæniæ procured from stray dogs examined by me in Adelaide (Plate V.).

Plate I (After RASMUSSEN)

p. 190 I E. Spiller Photo-lith

PLATE I.

Fig. 1.—Incipient formation of brood-capsules in a secondary cyst: *a*, the knob-shaped pivot; *b*, commencing formation of a cavity in the same by differentiation of the parenchyma; *c*, wall of the mother cyst.

Fig. 2.—Later stage of the brood-capsule: *a*, scolex knob; *b*, cavity with cuticle and internal parenchyma; *c*, external parenchyma; *d*, wall of mother cyst.

Fig. 3.—Brood-capsule with a single scolex: *a*, its outer cellular layer; *b*, its cuticle; *c*, internal parenchyma; *d*, scolex.

Fig. 4.—Daughter cyst formed of a brood-capsule: *a*, cuticle; *b*, internal parenchyma; *c*, scolices.

Fig. 5.—Daughter cell developed from a brood-capsule with a single scolex: *a*, cuticle; *b*, parenchyma; *c*, scolex.

Fig. 6.—A similar cell with capsuled scolex *(a)*.

Fig. 7.—Cut off brood-capsule, of which only one part is developed to form a daughter cell: *a*, cuticle of the daughter cell; *b*, parenchyma; *c*, cuticle of the brood-capsule; *d*, scolex.

Fig. 8.—Daughter cell developed from a brood-capsule (magnified about sixty times): *a*, cuticle; *b*, parenchyma; *c*, calcareous bodies; *d*, hooks.

Fig. 9.—A similar constricted daughter cell (magnified thirty times): *a*, cuticle; *b*, parenchyma; *c*, a hook; *d*, calcareous bodies.

Plate II, (After RASMUSSEN

p. 180-1

E. Spitzer Photolar.

PLATE II.

Fig. 1.—Tertiary daughter cell, with exogenous development of quaternary cysts (magnified 220 times): *a*, cuticle; *b*, parenchyma; *c*, persistent circlet of hooks; *d*, constricted petiolate cyst; *e*, eversion; *f*, same commencing.

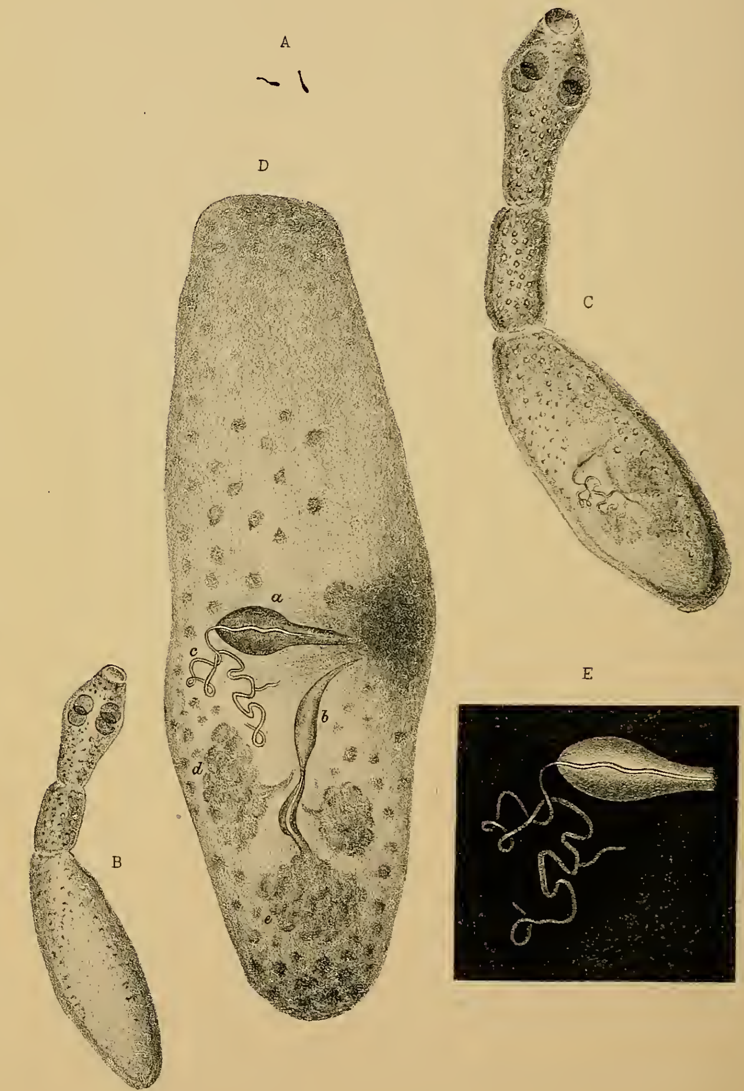
Fig. 2.—Daughter cell with perishing solices and internal cyst formation (excapsuled scolex): *a*, cuticle; *b*, parenchyma; *c*, circlet of hooks; *d*, internal cyst; *e*, its cuticle.

Fig. 3.—Daughter cell, developed from a brood-capsule with a single scolex: *a*, cuticle; *b*, parenchyma; *c*, perishing scolex.

Fig. 4. - Parencyma of a burst daughter cell with perishing scolices: *a*, parenchyma; *b*, scolex; *c*, crown of hooks of the same; *d*, two capsuled scolices.

Fig. 5.—Daughter cyst, developed from a brood-capsule by constrictions: *a*, principal cyst; *b*, *c*, *d*, *e*, cut off cysts.

Plate III



J. D. Dunlop del.

E. Spiller, lith.

PLATE III.

Tænia Echinococcus. Twenty days old.

A. Tænia of natural size.

B. Same, magnified twenty diameters.

C. Same as seen at 1in. focus.

D. Terminal segment, showing *(a)* cirrus sac containing cirrus; *b*, vagina; *c*, coiled vas deferens; *dd*, ovaries; *e*, "yelk sac"—highly magnified.

E. Coiled vas deferens, as demonstrated by Dr. Whittell by means of Paraboloid illumination.

(Bred from Echinococci of man.)

Plate IV

J. D. Dunlop, del. et. lith.

E. Spiller, imp.

PLATE IV.

Tænia Echinococcus. Thirty-two days old.

A A A A. Tænia showing three joints (twenty diameters).

B B. Specimens showing only two joints (twenty diameters).

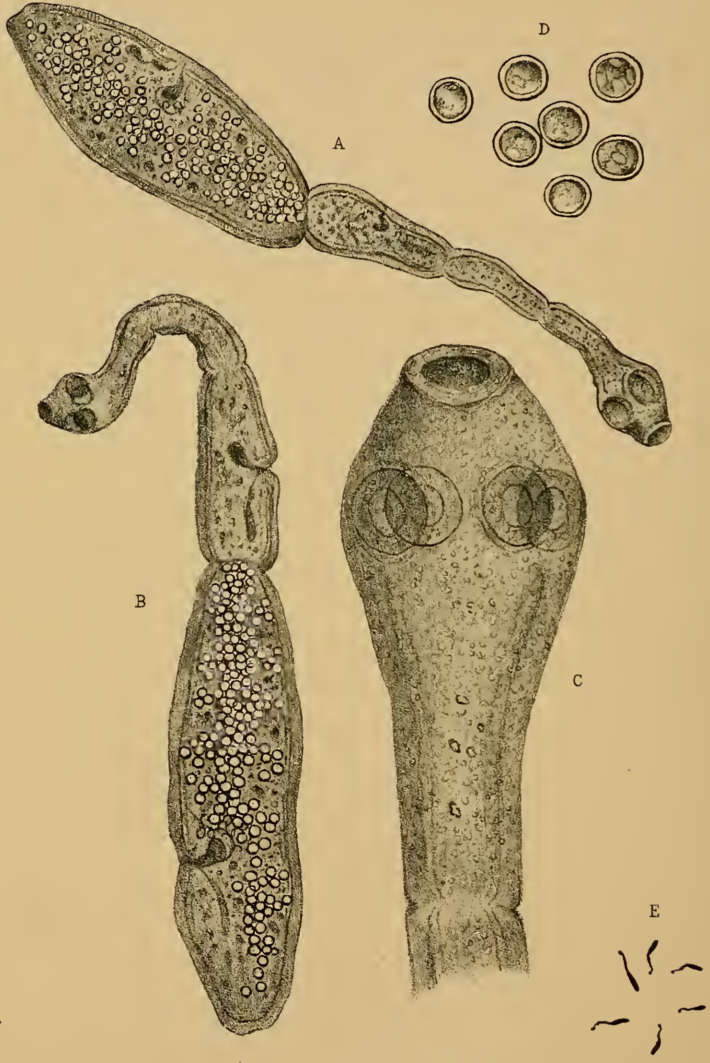
C. Head, showing suckers and double crown of hooks (320 diameters).

D. Hooklets, highly magnified.

E. Tænia of natural size.

(Bred from Echinococci of man.)

Plate V.



J. D. Dunlop del. et lith.

E. Spiller, imp.

PLATE V.

Mature Specimens of Tænia Echinococcus.

A. Tænia, showing ripe eggs as well as cirrus sac and vagina, placed on the *same* side in the last two joints (unusual), twenty-five diameters.

B. A similar specimen, but showing the sexual outlets on *opposite* sides in the last two joints (the usual arrangement), twenty-five diameters.

C. Head highly magnified (about 320 diameters), devoid of hooklets from old age.

D. Eggs highly magnified (about 560 diameters).

E. Tapeworms, natural size.

(Procured from stray dogs in Adelaide.)

INDEX.

2 F